

385 2000 09 OCT 1998

FORM PTO-1390 (Modified)
(REV 10-95)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

08086/002002

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

09/171043

INTERNATIONAL APPLICATION NO.
PCT/US97/05969

INTERNATIONAL FILING DATE
10 APRIL 1997

PRIORITY DATE CLAIMED
10 APRIL 1996

TITLE OF INVENTION

COMPUTER-BASED SYSTEM FOR WORK PROCESSES THAT CONSIST OF INTERDEPENDENT DECISIONS INVOLVING ONE OR MORE PARTICIPANTS

APPLICANT(S) FOR DO/EO/US

PAUL M. KONNERSMAN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

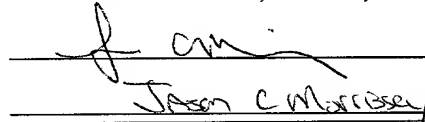
Items 13 to 18 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
A **SECOND** or **SUBSEQUENT** preliminary amendment.
16. ☐ A substitute specification.
17. ☐ A change of power of attorney and/or address letter.
18. ☒ Certificate of Mailing by Express Mail
19. ☐ Other items or information:

"Express Mail" label number : EL115288541US

Date of Deposit : 9 OCTOBER 1998

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner of Patents, Box PCT, Washington, D.C. 20231.


Jason C. Morrissey

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	INTERNATIONAL APPLICATION NO. PCT/US97/05969	ATTORNEY'S DOCKET NUMBER 08086/002002
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20. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :				CALCULATIONS PTO USE ONLY	
<input type="checkbox"/> Search Report has been prepared by the EPO or JPO		\$930.00			
<input checked="" type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482)		\$720.00			
<input type="checkbox"/> No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))		\$790.00			
<input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO		\$1,070.00			
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)		\$98.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$720.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	x \$22.00	\$0.00	
Independent claims	4 - 3 =	1	x \$82.00	\$82.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$802.00	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input checked="" type="checkbox"/>				\$401.00	
SUBTOTAL =				\$401.00	
Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30 +				\$0.00	
TOTAL NATIONAL FEE =				\$401.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$401.00	
				Amount to be: refunded	\$
				charged	\$


☒ A check in the amount of **\$401.00** to cover the above fees is enclosed.

☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **06-1050** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Gary A. Walpert Fish & Richardson PC 225 Franklin Street Boston, Massachusetts 02110	 SIGNATURE Gary A. Walpert NAME 26,098 REGISTRATION NUMBER 9 October 1998 DATE
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APPLICATION
FOR
UNITED STATES LETTERS PATENT

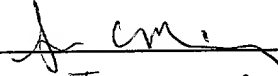
TITLE: **COMPUTER-BASED SYSTEM FOR WORK PROCESSES THAT
CONSIST OF INTERDEPENDENT DECISIONS INVOLVING
ONE OR MORE PARTICIPANTS**

APPLICANT: **PAUL M. KONNERSMAN**

"EXPRESS MAIL" Mailing Label Number EL115288541US

Date of Deposit OCTOBER 9, 1998

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Jason C Morrissey

09/171043

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300 Rec'd PCT/PTO 09 OCT 1998

Computer-Based System for Work Processes that consist of Interdependent Decisions involving one or more Participants.

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FIELD OF THE INVENTION

The present invention pertains to the field of computer-supported collaborative work. More specifically it presents a method and apparatus for (1) analyzing the requirements of such work, (2) specifying the process by which such work shall be carried out, (3) instantiating work projects based upon the specified process pattern and (4) implementing computer-based systems to support the execution, control, and improvement of such collaborative work.

BACKGROUND OF THE INVENTION

"Best practice" in accounting, financial transaction processing, order processing, inventory management, and purchasing has benefitted greatly from, and is heavily dependent on, the use of information technology. Although desktop computers have become ubiquitous in other areas of business such as, engineering, marketing, sales and general management, the benefits have been far more modest. In these areas of largely professional and managerial work, computers have been used extensively to support the work of individuals. But information technology has been more difficult to exploit in professional and managerial work that requires significant collaboration among individuals. Three general approaches have been taken to leverage technology in the service of managerial and professional work—workgroup software, workflow software, and decision support software.

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Workgroup software focuses on the need for communication among the many participants in managerial and professional work processes. It can be used to breach the organizational boundaries, both within and among
5 organizations, and is adaptable to almost any set of organizational circumstances. Such flexibility can be advantageous when the requirements for communication are poorly understood or constantly changing. However, there are costs incurred for such flexibility. The
10 administration and operation of such applications may become quite complex. Furthermore, it is sometimes advantageous to restrict the forms that a process may take to achieve not only greater economy but increased repeatability and reliability.

15 Workflow software is grounded in the paper metaphor of document routing. It should be economical in its use of resources and provide high repeatability due to a more restrictive, and therefore more definitive, structure than workgroup software. However, workflow
20 software is better suited to clerical, document processing activities than to managerial and professional work. In contrast to clerical activities in which most decision situations are well understood and can be made by a single individual, managerial and professional work
25 often entails decisions in which a number of people need to collaborate. This essential need for collaboration is the root of the ever present meetings that managers and professionals everywhere bemoan.

Early decision support software used information
30 technology to support individual decision makers with data retrieval and data manipulation capabilities that could significantly enhance the quality of their decisions. Recent efforts have expanded decision support for individual decisions to group settings. However,
35 decision support software does not attempt to structure

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the roles played in the decision by various individuals, nor does it usually structure the interdependencies of more than a few closely related decisions.

Professional And Managerial Work Processes.

- 5 Professional and managerial work processes characteristically result, not in products made of wood, steel or plastic, but products that are composed predominately or even entirely of data. Business plans, product specifications, labels, advertisements, computer
10 software, consulting reports, purchase orders, quotations, requests for quotation, and publications of all sorts, are typical products of managerial and professional work processes.

- The data assemblies that are produced by
15 managerial and professional work processes, like their physical counterparts, are sometimes built up in stages as sub-assemblies (e.g., the nutritional content section of the food package label, the terms and conditions section of the product quotation). This tiered structure
20 is illustrated by Figure 1, and more generally and succinctly by Figure 2.

- Each data element, whether elementary, a sub assembly or final assembly, is the product of a decision. That is, it is selected from two or more alternatives.
25 For example, the color specified in a product specification might be red, green, or blue. The business plan that includes a \$3 million advertising budget could have instead, included one for \$2.5 or \$2 million. Or it could have included separate line items for advertising
30 by geographic region, or by type of media, or by product line, or various combinations of these possibilities. What it does contain is a matter of choice (i.e, a decision) and results in data.

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The data assemblies that result from managerial and professional work processes are the product of numerous decisions. More importantly, many of these decisions are logically, and therefore temporally
5 ordered. Just as we cannot assemble a computer before we produce its subassemblies, nor its subassemblies before the components it contains, neither can we assemble a business plan or a quotation before we make the decisions that produce the data from which it is assembled. There's
10 a logical requirement that the components exist before the assembly.

In the physical work of manufacturing, there are also temporal precedence requirements that involve the transformation of materials, rather than the assembly of
15 components. Raw material must be reduced to powder or a molten state before it can be cast. And it must be cast before it can be machined. Analogously, in managerial and professional work processes data is sometimes required as the raw material for a decision even though it doesn't
20 show up as a component of that decision's result. For example, the decision to label a product either "corrosive" or "non-corrosive" may require a prior determination of the product's pH. The pH is raw material that is processed, perhaps with other data, by the
25 "Corrosive?" decision, but does not become a component of the result of the "Corrosive?" decision. Similarly, the number of households owning fewer than two television sets may be data that is required for the "Market Potential?" decision, but it is not assembled into that
30 decision. However, both the market potential number and the number of households owning fewer than two TV's would probably be components of the assembly, "Product Marketing Plan".

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Need for Participation in Decision-Making. For a number of years there has been widespread recognition that it is desirable to get more people involved in important organizational decisions. The decisions made and actions taken in a complex organization composed of interdependent units frequently require contributions and commitments from many individuals if they are to succeed. Although this may seem a recent phenomenon, the interdependence and complexity were always there. In the past most people were not aware of it, nor did they need to be. Organizations ignored much of the complexity and used extra resources (e.g., people, inventories, equipment, time, etc.) to decouple the interdependencies.

But as progressive organizations began to use information technology to reduce the slack in their organizations and to increase their ability to deal with complexity, they gained competitive advantage. Others have had to follow or perish. In most businesses the elimination of slack resources has exposed inadequacies in the organizational infrastructure. The inability to adequately integrate and coordinate decision-making across tightly coupled organizational layers and functions is often a problem.

Involving others in decision-making is a way of integrating and coordinating complex organizational activity. The advantages of a more participative decision process include not only better decisions because of better information, but more readily implementable decisions because of the commitment of the participants to carry it out. Nevertheless, the results from involving more people in decision-making have frequently been disappointing at best and a frustrating waste of time at worst. In the '70's, "participative management" was espoused by academics, promoted by consultants, and loudly proclaimed by many managements. The

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disappointment, if not disillusionment that followed, was of course predictable. It was yet another case of a very valid and useful idea that was over-promoted and under-invested.

5 In the '80's "participative management" was superseded by the coming of "teams" with similar results. It is often at least useful, and perhaps essential, for a group of people to work together interactively—as a team. It is seldom adequate however, to roundup a group, anoint
10 them with "teamhood," provide team T-shirts and send them off to play the game. The football, basketball, and other teams that provide the model for organizational teams, don't usually play the game without considerable investment in learning how to "block and tackle" and then
15 practicing the "blocking and tackling" repeatedly until they do it really well. They also develop "play books" and shared understanding of cryptic signals. They learn to anticipate each others' moves, again as a result of much practice together. Where are the organizational
20 equivalents of these indispensable requirements for the success of athletic teams? What one usually finds is a one day, or at most one week course, followed by a return to the workplace bearing an appropriately emblazoned coffee mug and plaque for the wall.

25 Participative decision-making was and is a good idea. However, it is an idea that contains several traps for the unwary. A common trap is the assumption (usually unexamined and unstated) that participation means equality—that everyone who participates, participates in
30 the same way and to the same degree. From that assumption flows the further assumption that everyone gets a vote, that the majority rules or that unanimity or consensus must be achieved if a decision is to be made. While there may be situations where such assumptions are appropriate,

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in most organizational situations they are neither desirable nor realistic.

A critical omission from many organizational teams is an appropriate set of clearly differentiated roles for the players and a related vocabulary. The "players" need a way to communicate effectively with one another about the "positions" they are playing, the "moves" they intend to make, and what they expect of their colleagues.

We need a method to analyze, specify and support work processes that consist of many, interdependent decisions, at least some of which require collaboration among multiple participants for satisfactory results. This is at least part of an answer to two critical problems currently faced by most complex organizations-

- 1) How to get better integration of effort across organizational boundaries, both those created within organizations (e.g., between engineering and manufacturing, or eastern sales region and central sales region) and the boundaries between organizations (e.g., customer and supplier, business and government, federal government and state government), and 2) How to improve the performance of managerial and professional work, where such performance may be measured in terms of reliability of the process in producing quality output, the productivity of the process, or the speed of the process

SUMMARY OF THE INVENTION

The present invention provides a novel way of using information technology in support of professional and managerial work processes. The approach is based on the modeling of professional and managerial work processes as networks of multiple, interdependent decisions, some of which may involve multiple participants in specific, differentiated roles. The proposed method entails the modeling of the work process

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using several familiar entities- decisions, decision rules and data- and another less familiar set of entities- decision roles. The work process model produced using these entities is used as a pattern for the

5 generation of project models. These project models are a central element in a computer- and communications-based infrastructure to direct and guide the behavior of the participants in the work process.

Like both workflow and workgroup software, this
10 approach recognizes the importance of facilitating communication among collaborating individuals. Like decision support software, this approach recognizes the utility of assisting workers with access to appropriate data and the manipulation of that data. Unlike other
15 approaches the proposed approach provides a method for structuring professional and managerial processes modularly using object technology and with a degree of structure that can be varied for each object independently. When understanding of the work process is
20 great, that knowledge can be used to build more highly structured, and therefore more valuable, supporting infrastructure. Where less precise or less fully defined understanding of the work process is all that is available, the proposed method allows a correspondingly
25 less structured supporting infrastructure that can be enhanced as understanding of the process increases.

The exploitation of information technology in support of professional and managerial work has been limited by failure to specify the processes used to
30 accomplish such work. The available tools for modeling and specifying such work have been inadequate. The present invention is based on a methodology that addresses this inadequacy. Professional and managerial work processes are modeled as networks of linked
35 decisions and data. The decisions that make up such work

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often require significant participation of many people. The approach utilized by the present invention identifies the roles that are useful and provides specifications for the behavior and requirements of individuals playing
5 those roles.

Decision Networks. Every decision produces a result in the form of data. Although any decision may be viewed in isolation, it is useful to identify the data required to make the decision. That data is in turn the
10 result of one or more other decisions. Therefore, the decision that requires data is dependent on the decisions that produce it (See Figure 3). Therefore, if we establish the interdependencies among decisions based on our understanding of the data they produce and the data
15 they require, we have established a basis for both routing data and triggering decision situations. That is, send a data element to all decisions requiring it, and trigger a decision when all required data has been received.

20 Each decision is viewed as an "atomic" process-taking required data and processing it to produce a result as output data. The decisions that make up professional and managerial work processes are typically related to other decisions by virtue of their need for
25 data resulting from earlier decisions. FIG. 4 depicts a typical decision process, in this case a proposal preparation process for some equipment. The nodes of the network are the decisions with their associated data output. The decision interdependencies are depicted as
30 directed arcs connecting the nodes. The connecting arcs run from the independent decision at the entry of the arc to the dependent decision at the exit end of the arc which is indicated by an arrowhead. Professional and managerial work processes are treated therefore, as

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"molecular" networks of such "atomic" decision processes that convert data to a desired output. The method of the present invention couples these decision networks to a structure for participation by multiple individuals in
5 the "atomic" decision processes.

Decision Roles & Responsibilities. A structure is needed for successful participative decision-making that explicitly recognizes the different reasons for participation and the different capacities in which
10 participants can be expected to contribute. It has proven useful to distinguish five decision roles, namely: Decision Manager, Consultee, Approver, Inspector, and Informee.

The Decision Manager plays the central role that
15 has traditionally been associated with the term "decision maker," that is, making the choice of one from among two or more possible options. However, the role also carries critical additional responsibilities. The Decision Manager must manage the decision process and take
20 responsibility for implementation of the decision. Our paradigm of the "decision maker" has been profoundly influenced by our experience of decision-making as a solitary, rather than a group process. The term "Decision Manager" has been deliberately chosen here to help break
25 the paradigm's hold on our thinking - to emphasize responsibility for the *conduct of the decision process* rather than for the mere *selection of an alternative*. The decision maker has usually been associated only with the latter responsibility. Our Decision Manager is
30 responsible for both the choice and the process of choosing.

The role of a Consultee is to provide either expertise required to make a good decision or commitment of resources needed for successful implementation. A

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Consultee has a right to the opportunity to influence the Decision Manager's choice, not a right to veto that choice. The consultation process, which is managed by the Decision Manager, may take any of several forms at the discretion of the Decision Manager. In decision situations that require more than two or three Consultees or that are new, unclear or complex, the Decision Manager may find it appropriate to bring the Consultees together for one or more face-to-face meetings. This differs from common practice only in having more thoughtfully selected attendees, more explicit delineation and definition of attendee roles, and a more precisely focused agenda. Usually, where the number of Consultees is few, or the decision straight forward, face-to-face meetings are probably unnecessary. Instead, the Decision Manager may hold a tele-conference, or she may simply solicit participation from the Consultees individually by any means of communication available, with or without some preliminary indication of the decision result that she has in mind. The only requirement is that the Consultees feel that they have had an adequate opportunity to influence the Decision Manager's choice.

An Approver's role is to prevent organizationally intolerable outcomes that might result from a decision made without the benefit of some expertise that the Approver has, and is not otherwise available to the Decision Manager. The other reason for an Approver is to assure that the decision has not been unduly influenced by the parochial interests of the Decision Manager to the detriment of the organization. The Approver role is like the Consultee role with two important differences. The Approver has veto power (i.e., he must be satisfied with the decision result and the process) and the Approver does not participate fully in the deliberations that take place before the decision. It is desirable for the

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Approver to be informed about the progress and content of lengthy and complex deliberations as they go on, rather than being informed at the conclusion. However, the Approver's full participation in the pre-decision
5 deliberations would severely undermine the role of the Decision Manager, since the Approver would essentially be taking on the role of Decision Manager. (It would be better to make the Decision Manager a Consultee and make the Approver the Decision Manager- explicitly.)

10 An Informee's role is to make subsequent decisions and perform subsequent tasks in a way that is consistent with the decision made. The defining characteristic of this role is that, while an Informee's participation in the deliberations leading up to the decision is not
15 useful, his or her failure to participate in carrying out the decision may seriously undermine the implementation. Consider, for example, the payroll clerk. In most organizations it would not be useful to include the payroll clerk in decisions regarding the size of salaries and
20 bonuses to be awarded. But failure to inform the clerk of the decision once it has been made, renders the decision moot.

The Inspector's role is to ensure that the result of a decision conforms to any published specifications.
25 Individuals who are called "approvers" are often merely inspectors. These so-called "approvers" are checking to see that others have done what they were supposed to have done-that is, they are checking to see that the result of the decision conforms to some set of specifications. For
30 example, a lawyer may check to see that the copyright and trademark notices have been properly displayed. A marketing manager may verify that the artist has used the correct colors. This is a different role than the one we have outlined above in that the requirements are fully
35 established and the so-called "approver" is simply

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checking to see that they have been met. Unlike the Approver's role, these tasks could be delegated to any conscientious person. This is an inspector's job and we therefor call the role "Inspector."

- 5 The five decision roles and their specific responsibilities to others are set forth in Table A.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, the preferred embodiment of the invention and preferred methods of practicing the invention are illustrated in which:

10

FIG. 1 is an object diagram illustrating a prototypical aggregation of data.

FIG. 2 is an object diagram defining the general aggregation of data.

- 15 FIG. 3 is a schematic diagram illustrating the relationship of data to decisions and the linking of decisions through data.

FIG. 4 is a schematic diagram illustrating the network structure of decisions in a typical decision process - in this instance a hypothetical proposal preparation process.

20

FIG. 5 is a class diagram illustrating the abstract and concrete classes comprising the application framework of the present invention.

- 25 FIG. 6 is a class diagram illustrating the relationship between two of the abstract classes, Decision and Data, of the application framework and their concrete classes and object instances.

FIG. 7 is a class diagram depicting the classes and objects comprising a prototypical process model generated with the application framework of the present invention (reference made to FIG. 4).

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FIG. 8 is a class diagram depicting the classes and objects comprising a prototypical project model instantiated by the prototypical process model of FIG. 7.

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FIG. 9 is a class diagram depicting the classes of the application framework of the present invention and their relationships to one another.

FIG. 10 is state diagram depicting the aspects of the Project object that change over time.

FIG. 11 is state diagram depicting the aspects of the Decision object that change over time.

FIG. 12 is state diagram depicting the aspects of the Data object that change over time.

FIG. 13 is state diagram depicting the aspects of the Directed Arc object that change over time.

FIG. 14 is state diagram depicting the aspects of the Arc Entry Collection object that change over time.

FIG. 15 is state diagram depicting the aspects of the Arc Exit Collection object that change over time.

FIG. 16 is state diagram depicting the aspects of the Decision Manager object that change over time.

FIG. 17 is state diagram depicting the aspects of the Consultee object that change over time.

FIG. 18 is state diagram depicting the aspects of the Inspector object that change over time.

FIG. 19 is state diagram depicting the aspects of the Approver object that change over time.

FIG. 20 is state diagram depicting the aspects of the Informee object that change over time.

FIG. 21 is a data flow diagram depicting the data flow and value transformations required to instantiate a Project object and the Decision, Directed Arc and Arc Collection objects of the Project.

FIG. 22 is a data flow diagram depicting the data flow and value transformations required to instantiate Decision Role objects.

FIG. 23 is a data flow diagram depicting the data flow and value transformations required to instantiate Data objects.

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FIG. 24 is a data flow diagram depicting the data flow and value transformations required to iterate a Project object.

DESCRIPTION OF THE PREFERRED EMBODIMENT

5 **Glossary.** The discussion of the present invention utilizes certain terms in a precise sense. The following definitions of those terms are provided for clarity.

"Decision" means a decision situation in which a choice is to be made from among two or more alternatives (e.g., color?, corrosive?, price?, supplier? quantity?). The number of alternatives may be infinite or unknown.

10 "Data" means the result of the act of deciding (e.g., red, yes, \$5.00 each, Acme, 650) . A data element may be divisible into constituent data elements (e.g., cells in a matrix, items in a list, characters in a string, delimited areas of a graphic).

"Decision Role" means the set of behaviors prescribed for a participant in a decision (e.g., Decision Manager, Consultee, Approver, Inspector, Informee) . There can be any number of different roles defined for participants.

25 "Position" means position or job in an organization, usually designated by a title (e.g., President, CEO, Quality Manager, Foreman, Chemist) and job description.

"Process" means a system that converts inputs to outputs (e.g., computer system, manufacturing system, water purification system, justice system).

30 "Decision Process" means a process whose inputs and outputs are data, or artifacts containing data (e.g., business planning process, product development process, sales process, customer support process), and whose principal components are decisions.

"Process Model" means a model constructed of both concrete and abstract classes and object instances of

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some of those classes, that specifies and defines the way in which the work of a decision process will be performed.

"Project" is an instance of a process model (e.g., this year's business plan, the development of an improved widget, getting the Acme Company order, addressing the issues at Consolidated Corp.).

Terms of Art. The invention has been developed and is presented here using the conventions and practices of Object Modeling Technique (OMT).

A class is an abstraction that describes properties important to an application and ignores the rest. ... Each class describes a possibly infinite set of individual objects. Each object is said to be an instance of its class. (James Raumbaugh, Michael Blaha, William premerlani, Frederick Eddy, and William Lorensen, *Object-Oriented Modeling and Design*, Prentice Hall: Englewood Cliffs, NJ, 1991, p. 2)

An *abstract class* is a class that has no direct instances but whose descendent classes have direct instances. A *concrete class* is a class that is instantiable; that is it can have direct instances. (*ibid.*, p. 61)

The OMT methodology uses three kinds of models to describe a system: the *object model*, describing the objects in the system and their relationships; the *dynamic model*, describing the interactions among objects in the system; and the *functional model*, describing the data transformations of the system. Each model is applicable during all stages of development and acquires implementation detail as development progresses. A

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complete description of a system requires all three models.

The *object model* describes the static structure of the objects in a system and their relationships. The
5 object model contains object diagrams. An *object diagram* is a graph whose nodes are object classes and whose arcs are *relationships* among classes. ...

The *dynamic model* describes the aspects of a system that change over time. The dynamic model is used
10 to specify and implement the *control* aspects of a system. The dynamic model contains state diagrams. A *state diagram* is a graph whose nodes are *states* and whose arcs are *transitions* between states caused by events. ...

The *functional model* describes the data value
15 transformations within a system. The functional model contains data flow diagrams. A *data flow diagram* represents a computation. A data flow diagram is a graph whose nodes are *processes* and whose arcs are *data flows*.
...

20 The three models are orthogonal parts of the description of a complete system and are cross-linked. The object model is most fundamental however, because it is necessary to describe *what* is changing or transforming before describing *when* or *how* it changes....

25 ...Object-oriented development places a greater emphasis on data structure and a lesser emphasis on procedure structure than traditional functional-decomposition methodologies. ...[It] adds [and relies on] the concept of class-dependent behavior. (*ibid.*, pp. 6-7)

30 Abstract classes form the basis of a framework. If abstract classes factor out enough common behavior, other components, that is, concrete classes or other abstract classes, can be implemented based on the contracts

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offered by the abstract classes. A set of such abstract and concrete classes is called a framework.

The term *application framework* is used if this set of abstract and concrete classes comprises a generic
5 software system for an application domain. Applications based on such an application framework are built by customizing its abstract and concrete classes. In general, a given framework anticipates much of a software systems' design. The design is reused by all software
10 systems built with the framework. (Wolfgang Pree, *Design Patterns for Object-Oriented Software Development*, Addison-Wesley: Reading, MA, 1995, p. 54.)

Conventions. References in the description to specific elements of figures are keyed with numerals that appear
15 bold-faced in both the text and the figure. Numeric references to classes and their objects are numerals below 200 and are consistent across all figures. All other numeric references are specific to the particular figure. Notation used in figures is generally that of OMT
20 (Rumbaugh, *et.al.*, *op. cit.*, inside front & back covers.). Class, object and state names are capitalized. Abstract class names are also italicized and underscored in figures, but not in the text. A question mark, "?", at the end of a class name is used to distinguish a concrete
25 decision class or object name from their related concrete data class or object names.

Framework Architecture. The present invention consists of an application framework for the development of abstract, decision process models. Each such decision
30 process model is used as a pattern to instantiate concrete project models that incorporate the work defined by the abstract process. The framework is built around a core set postulates - 1) the work of the process requires

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the production of data or artifacts incorporating data,
2) decisions are the processes that produce data, 3) some
decisions themselves require data, either as raw material
which is processed or as a component of a data assembly,
5 4) some decisions require the participation of two or
more persons in differentiated roles, 5) a process model
specifies how work shall be done, 6) a project is a unit
of work performed in accordance with the process, and 7)
decisions that require data are logically, and therefore
10 temporally dependent on the decisions that provide the
required data.

Object Model

The Framework 99 is constructed from a related
set of abstract and concrete object classes that are
15 depicted in FIG. 6. The abstract Decision class 100 has
members that are classes of decisions which are specific
to the application domain. In the example, depicted in
FIG. 4, all of the boxes representing nodes of the
network would be modeled as concrete class instances of
20 the Decision class 100. This relationship between the
abstract Decision class 100 and some of it's concrete
classes and object instances are more clearly depicted in
the upper half of FIG. 6. The Data class 101 is also an
abstract class that has a one-to-one relationship with
25 the Decision class 100. The relationship between the
abstract Data class 101, its concrete classes and their
object instances is shown in the lower half of FIG. 6.
Referring again to FIG. 5, the other abstract classes of
the Framework 99 are Arc Collection 115 and Decision Role
30 121. The Arc Collection class 115 has two concrete
subclasses, Arc Entry Collection 134 and Arc Exit
Collection 136. The instances of these classes are
collections of Directed Arc 107 objects which are

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instances of another one of the Framework's 99 classes. These two subclasses are differentiated by the end of the Directed Arc 107 object that they use to determine their members; the former using the entry end of the Directed Arc 107 object (the end without the arrowhead in FIG. 4) and the latter using the exit end. The abstract Decision Role class 121 has five concrete classes in the preferred implementation, Decision Manager 142, Consultee 143, Approver 144, Inspector 145, and Informee 146. These four concrete, subclasses model the behaviors and responsibilities described in Table A. As indicated in FIG. 5, there will be exactly one Decision Manager 142 related to each Decision 100. There may or may not be any Position 119 designated to participate 120 in a Decision 100 in any of the other four roles 143, 144, 145, and 146. Nor is there a limit on the number of Positions 119 that may participate 120 in any of these latter four roles. The final classes of the Framework 99 are the concrete classes Position 119 and Person 116 which model the organization and the incumbents of the organization respectively.

The Framework 99 depicted in FIG. 5 has both abstract and concrete classes but no objects. Two of its abstract classes do not have any concrete classes. FIG. 7 depicts classes and objects of a hypothetical Process Model 129 derived from the Framework and based on the example depicted in FIG. 4. In addition to the elements of the Framework depicted in FIG. 5, the Process Model 129 has concrete subclasses Cost 10, Price 11, Terms 12 etc. of the of the abstract Data class 101, and concrete subclasses Cost ? 14, Price ? 15, Terms ? 16 etc. of the of the abstract Decision class 100. (the short broken lines 13 and 17 indicate that there are other concrete subclasses of these two abstract classes which have been omitted for clarity.) The Framework 99 abstracts the

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desired behavior common to all decision processes whether they be a proposal preparation process, a product development process, or a strategic planning process. The Process Model 129 is more concrete and specific. It abstract only those desired behaviors that are common to the particular decision process being modeled, in the example illustrated in FIG. 4, FIG. 6, and FIG 7, the proposal preparation process of the organization or organizations that use this particular process. The Process Model 129 also includes the objects which are instances of the concrete classes Directed Arc 107, Arc Entry Collection 134, Arc Exit Collection 136, Position 119, and the five concrete subclasses of the Decision Role class 121 to the extent that any are specified for this particular process.

The only potential objects that are missing from the Process Model 129 are the objects that are instances of the concrete subclasses of Decision 100 and Data 101 and the concrete class Person 116. Unlike the objects that are included in the Process Model 129, the missing objects are expected to change from project to project as the process is followed. These are the objects that belong to the Project Model 127 and are so depicted in FIG. 8 (see 23, 24 and 25).

FIG. 9 depicts the classes of the Framework 99 with all of their important associations, some of which were omitted from the foregoing figures and discussion. As illustrated in FIG 9, each instance of the Decision class 100 produces 102 one, and only one, instance of the concrete subclasses of Data class 101. The instances of Data 101's concrete classes, may be of any type including two-valued boolean, simple scalars, text strings or more complex types such as matrices, graphics or documents. Data 101 is also related to Decisions 100 in another way. A Decision 100 may require 103 one or more elements of

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required Data 104 as input. A Decision 100 in such a relationship with required Data 104, is a requiring Decision 105. For example, the "quoted price?" Decision 100 may require 103 the required Data 104, "quantity
5 quoted", which is produced 102 by the "quantity to quote?" Decision 100. The "quoted price?" Decision 100 might also require Data 104 from the "customer class?", "delivery requirement?", "terms quoted?", and "competitive situation?" Decisions 100.

10 Each element of required Data 104 has 106 one or more Directed Arcs 107 which are paired 132 one-to-one with the required by 103 relationship between each element of required Data 104 and each of the requiring
15 Decisions 105. Each Directed Arc 107 is related at its exit 108 end to the requiring Decision 105 of the related 106 required Data 104. At its entry 109 end, each Directed Arc 107 is related to the producing Decision 110 of the required Data 104 associated 106 with the Directed Arc 107.

20 Requiring 105 Decisions 100 and their dependencies upon producing 110 Decisions 100 are connected by Directed Arcs 107 with an entry at the end of the arc connected to its respective producing 110 Decision 100 and an exit at the end of the arc connected to its
25 requiring 105 Decision 100. Each Directed Arc 107 is a member 133 of one Arc Entry Collection 134 comprised of 133 all and only those Directed Arcs 107 which have the same producing Decision 110. Each Directed Arc 107 is also a member 135 of one Arc Exit Collection 136
30 comprised of 135 all and only those Directed Arcs 107 which have the same requiring Decision 105. Arc Entry Collections 134 and Arc Exit Collections 136 are specializations of the Arc Collection 115 class, which specialization is based on whether the class is defined

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by its entry 109 relationship or its exit 108 relationship.

Persons 116 occupy 118 organizational Positions 119 which participate 120 in Decisions 100 in a Decision 5 Role 121 that defines the expected and acceptable behaviors associated with that participation 120.

A subset 122 of required Data 104 may be used as Rules 123. Such Rules 123 may be used to make 124 Decisions 100. For example, a rule for making a Decision 10 that converts "quantity quoted" and "list price" into "price quoted" might be "IF {quantity quoted} < 10, THEN {price quoted} = {list price}, ELSE {price quoted} = 0.9*{list price}." A Rule 123 may also be used to specify the applicability 125 of a Decision Role 121, or both 126 15 of an element of required Data 104 and 127 its associated 106 Directed Arc 107. Note that the Rule 123 determining the applicability of required Data 104 and the Rule 123 determining the applicability of its associated 106 Directed Arc 107 is constrained to be the same Rule 128 , 20 because required Data 104 and its associated 106 Directed Arc 107 must be either both applicable, or both inapplicable. Note also, that a Rule 123 may be used to specify the applicability 126 of another Rule 123, since that other Rule 123 is also an element of required Data 25 104. Examples of these uses of rules to govern applicability are:

(1) Decision Role 121 applicability 125: "IF {product category} = {lawn care}, THEN {Decision Manger} = {Product Manager, Lawn Care}, ELSE IF {product 30 category} = {snow blowers}, THEN {Decision Manger} = {Product Manager, Snow Handling}, ELSE {Decision Manger} = {Marketing Manager};"

(2) Directed Arc 107 and required Data 104 applicability 126 and 127, where required data does not 35 operate as a rule: "IF {product's 'kill claims'} =

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{none}, THEN {registration number} NOT REQUIRED by {label layout} AND Arc:{registration number} to {label layout} NOT APPLICABLE, ELSE; {registration number} REQUIRED by {label layout} AND Arc:{registration number} to {label layout} APPLICABLE;

(3) Directed Arc 107 and required Data 104 applicability 126 and 127, where required data does operate as a rule: "IF {product status} = {established}, THEN use {quantity discount rule}, ELSE, use {null rule}."

All of the foregoing object classes other than Project 127 aggregate to Process 129, which is managed 117 by a Person 116 occupying 118 a Position 119 which has been designated the "Process Manager." Alternatively, a Person 116 could be directly designated to manage 117 a Process 129 without an intervening Position 119. A Project 127 is instantiated 128 based on the pattern provided by the Process Model 129 and a related initial 130 Decision 100. The Project 127 network consists of an instance of the initial 130 Decision 100, together with an instance of each of the decisions in the Process 129 that require 103, directly or indirectly, the data 104 produced by 102 the initial 130 Decision, and an instance of all the Directed Arcs 107 connecting the initial 130 Decision 100 and the directly and indirectly requiring 105 Decisions 100. A Project 127 is managed 131 by a Person 116 designated the "Project Manager". Alternatively, a Person 116 could be designated to manage 131 a Project 127 via an intervening Position 119, as is indicated for management 117 of Process 129.

Dynamic Model

Dynamic Behavior of Project 127 Object. The dynamic behavior of the Project 127 object is depicted in FIG. 10. The Project 127 object is instantiated in Active

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451 state. If a project is put on hold the Project 127 object transits 452 to Suspended 453 state. Upon release from project hold the Project 127 object transits back to Active 451 state. If the project receives a pause 455 the Project 127 object transits 455 to Paused 456 state. Upon resume 457 the Project 127 object returns 457 to Active 451 state. If the project is aborted from any of its three states the Project 127 object transits 458, 459, or 460 out of existence.

10 **Dynamic Behavior of Decision 100 Object.** The objects of the domain-specific, concrete classes generated from the abstract Decision 100 class are the central controlling actors of the "atomic", intra-decision process. Referring to FIG. 11, upon its
15 instantiation 200 as a component of the a Project 127, a Decision 100 object is in Dormant 201 state. It remains in Dormant 201 state until activated by the Arc Exit Collection 136 related to it. When so activated, a Decision 100 object transits 202 to Decision Release
20 Pending 203 state. From Decision Release Pending 203 state, a Decision 100 object transits 204 to Prepare Consultation 205 state upon "release" if the number of Consultees 143 designated for the Decision 100 object is greater than zero. If the number of Consultees 143 is
25 zero, it transits to Deliberation 210 state, upon release. "Release" is the default value of a Decision 100 object's Release/Hold attribute. It can be toggled between "release" and "hold" by any authorized individual (most appropriately, the Project Manager) at any time
30 that the Decision 100 object is in Decision Release Pending 203 or Dormant 201 states. If the Release attribute is toggled to "release" while the Decision 100 object is in Decision Release Pending 203 state, the object immediately transits 204 or 209 to either Prepare

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Consultation 205 state or Deliberation 210 state depending upon whether it does or does not have Consultees 143 designated. Upon exiting Decision Release Pending 203 for the first time, a Decision 100 object
5 causes the instantiation of all its designated Decision Role 121 objects.

When in Prepare Consultation 205 state and the Decision Manager 142 is prepared to begin consultation with the designated Consultees 143, the Decision Manager
10 142 initiates the Decision 100 object's transit 206 to Consultation 207 state. Transit 206 causes notification to be sent to all designated Consultees 143, that Consultation 207 on this Decision 100 object has begun. When the Decision Manager 142 determines that the
15 requirements for consultation have been satisfied, the Decision 100 object transits 208 to Deliberation 210 state, causing notification of all Consultees 143. When the Decision Manager 142 enters the decision result, the Decision 100 object either transits 211 to Inspection 214
20 state, or transits 213 to Approval 215 state, or transits 212 to Standby 216 state, depending on whether the Decision 100 object has at least one Inspector 145 designated, or no Inspectors 145, but at least one Approver 144, or neither Inspectors 145 nor Approvers
25 144, respectively. From the Inspection 214 state, the Decision 100 object either transits 219 to Approval 215 state, or transits 220 to Standby 216 state when the result of inspection is "pass" and the Decision 100 object has, respectively, at least one Approver 144 or no
30 Approvers 144 designated. When the result of the inspection is "fail," the Decision 100 object in Inspection 214 state either transits 217 to Prepare Consultation 205 state or transits 218 to Deliberation 210 state, depending on whether the Decision 100 object
35 does or does not have any Consultees 143 designated. When

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a Decision 100 object is in Approval 215 state and the result is "deny," it either transits 222 to Prepare Consultation 205 state or transits 223 to Deliberation 210 state, depending upon whether the Decision 100 object does or does not have any Consulees 143 designated. If the result in Approval 215 state is "grant," the Decision 100 object transits 221 to Standby 216 state. Upon completion of a Project 127, all of the Project's Decision 100 objects will be in Standby 216 state and will transit 230 out of existence.

The states Prepare Consultation 205, Consultation 207, Deliberation 210, Inspection 214, Standby 216, and Approval 215 of a Decision 100 object aggregate to state InProcess 224. While a Decision 100 object is in InProcess 224 state, it may become necessary to reconsider, and therefore to iterate the Decision 100 object's decision process from its initial state. Therefore, such iteration causes a Decision 100 object in InProcess 224 state to transit 225 to Dormant 201 state, or if in Decision Release Pending 203 state, to transit 226 to Dormant 201 state. If the Project 127 of which the Decision 100 object is a part, is aborted while in any state, the Decision 100 object transits 227, 228, or 229 to out of existence.

Dynamic Behavior of Data 101 Object. Each Decision 100 object is associated one-to-one with the Data 101 object it produces 102. The dynamic behavior of Data 101 objects is depicted in FIG. 12. A Data 101 object is instantiated 240 in state Entry Pending 241 when the Decision Manager 142 of its producing 110 Decision 100 is ready to enter the decision result. Upon completion of the decision entry, the Data 101 object transits 243 to Inspection or Approval 245 state if there is at least one Inspector 145 or one Approver 144 designated for the

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Decision 100. Otherwise, upon decision entry the Data 101 object in Entry Pending 241 state transits 244 to Data Release Pending 246 state. When inspection results have been entered by all Inspectors 145 designated for

- 5 Decision 100, the inspection results are evaluated. If any such result indicates "fail," the Data 101 object's state transits 248 to Historical 249 state. If all inspections result in "pass," and there are no Approvers 144 designated for the Decision 100, the Data 101
- 10 object's state transits 251 to Data Release Pending 246 state. When there is at least one Approver 144 designated for said Decision 100, the approval review results are evaluated. If all required approvals are "granted," the Data 101 object's state transits 250 to Data Release
- 15 Pending 246 state. If any approval is "denied", the Data 101 object's state transits 247 to Historical 249 state.

- When a Data 101 object's "hold/release" attribute is set to "release" and it is in Data Release Pending 246 state, the Data 101 object transits 252 to Standby 253
- 20 state and sends "active" to its Arc Entry Collection 134. The "hold/release" attribute can be used to selectively retard a project's progress by toggling it to "hold" on selected Data 101 objects. When every Decision 100 object belonging to a Project 127 has an instantiated Data 101
- 25 object which is in state Standby 253, the Project 127 is complete and all Data 101 objects transit 254 to Operational 255 state. When Data 101 objects in Operational 255 state are superseded by a Data 101 object from a subsequent Project 127, the former Data 101 object
- 30 transits 256 to Historical 249 state. The states Inspection or Approval 245, Data Release Pending 246, and Standby 253 aggregate to state InProcess 257.

- If a Project 127 iterates across Decision 100 objects with related Data 101 objects that are in
- 35 InProcess 257 state, such Data 101 objects transit 260 to

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Historical 249 state. If a Project 127 iterates across Decision 100 objects with related Data 101 objects in Entry Pending 241 state, those Data 101 objects transit 261 out of existence.

- 5 If a Project 127 is aborted with Data 101 objects in InProcess 257 state, such Data 101 objects transit 258 to Historical 249 state. If a Project 127 aborts with Data 101 objects in Entry Pending 241 state, those Data 101 objects transit 259 out of existence.

- 10 **Dynamic Behavior of Directed Arc 107 Object.** The objects of the Directed Arc 107 class, are the central controlling actors of the "molecular", inter-decision process. FIG. 13 depicts the dynamic behavior of Directed Arc 107 objects. Upon instantiation 370, each Directed
15 Arc 107 object enters Dormant 371 state, notifying its related 135 Arc Exit Collection 136 of its state. When notified by its Arc Entry Collection 134 object that said collection has become active, a Directed Arc 107 object transits 372 to Active 373 state and, upon entering that
20 state, notifies its related 135 Arc Exit Collection 136 of its new state.. If, while in Active 373 state, the related Project 127 iterates over the related Decision 100 object, the Directed Arc 107 object transits 374 to Dormant 371 state, and upon entering that state, notifies
25 its related 135 Arc Exit Collection 136 object of its new state. If the Project 127 to which a Directed Arc 107 object belongs aborts, the Directed Arc 107 object transits 375 or 376 out of existence from either Dormant 371 or Active 373 state respectively.

- 30 **Dynamic Behavior of Arc Entry Collection 134 Object.** The dynamic behavior of the Arc Entry Collection 134 objects is depicted in FIG. 14. Upon instantiation 380 an Arc Entry Collection 134 object enters Dormant 381

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state and sends a message to its member 133 Directed Arc 107 objects containing its state. When notified by the Data 101 object produced by 102 the Decision 100 associated with its entry 109, that data release 252 has occurred, the Arc Entry Collection 134 object transits 382 to Active 383 state and sends it's new state to its member 133 Directed Arcs 107. If, while in Active 383 state, the related Project 127 iterates over the related Decision 100 object, the Arc Entry Collection 134 object transits 384 to Dormant 381 state, and upon entering that state, sends it's new state to its member 133 Directed Arcs 107. If the Project 127 to which a member 133 Directed Arc 107 object belongs aborts, the Arc Entry Collection 134 object transits 385 or 386 out of existence from either Dormant 381 or Active 383 state respectively.

Dynamic Behavior of Arc Exit Collection 136

Object. The dynamic behavior of the Arc Exit Collection 136 objects is depicted in FIG. 15. Upon instantiation 390 an Arc Exit Collection 136 object enters Dormant 391 state and sends a message containing its state to the requiring 105 Decision 100 object associated with its member 135 Directed Arc 107 object's exit 108. When all of its member 135 Directed Arcs 107 are in Active 373 state, the Arc Exit Collection 136 object transits 392 to Active 393 state and sends it's new state to the requiring 105 Decision 100 object associated with its member 135 Directed Arc 107 object's exit 108. If, while in Active 393 state, the related Project 127 iterates over the related Decision 100 object, the Arc Exit Collection 136 object transits 394 to Dormant 391 state, and upon entering that state, sends it's new state to the requiring 105 Decision 100 object associated with its member 135 Directed Arc 107 object's exit 108. If the

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Project 127 to which a member 135 Directed Arc 107 object belongs aborts, the Arc Exit Collection 136 object transits 395 or 396 out of existence from either Dormant 391 or Active 393 state respectively.

- 5 **Dynamic Behavior of Decision Manager 142 Decision Role 121 Object.** As depicted in FIG. 16, the Decision Manager 142 object is instantiated 265 in the Prepare Consultation 266 state. If there are no Consulees 143 designated for the related Decision 100 object the
- 10 Decision Manager 142 object immediately transits 268 to Deliberation 270 state. Otherwise, the Decision Manager 142 object transits 267 to Consultation 269 when the incumbent in the Decision Manager role indicates the beginning of consultation. The Decision Manager 142
- 15 object transits 271 to Deliberation 270 when the incumbent in the Decision Manager role indicates the end of consultation. The Decision Manager 142 object transits 271 from Deliberation 270 to Standby 272 state when the Decision Manager incumbent enters the decision result.
- 20 From Standby 272 state the Decision Manager 142 object either transits 273 or transits 274 upon inspection fail to either Prepare Consultation 266 state or Deliberation 270 state depending, respectively or whether the Decision 100 object does or does not have any Consulees 143
- 25 designated. Upon approval deny the Decision Manager 142 object either transits 275 or transits 276 from Standby 272 state to either Prepare Consultation 266 state or Deliberation 270 state depending, respectively or whether the Decision 100 object does or does not have any Consul-
- 30 tees 143 designated. States Prepare Consultation 266, Consultation 269, Deliberation 270, and Standby 272 aggregate to state InProcess 277. If the Decision 100 object to which the Decision Manager 142 object is related iterates, the Decision Manager 142 object

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transits 278 from state InProcess 277 to state Dormant 279. If the Project 127 object of which the Decision Manager 142 object is a component aborts, the Decision Manager 142 object either transits 283 from state InProcess 277 out of existence or transits 282 from state Dormant 279 out of existence. Upon Project 127 completion the Decision Manager 142 object either transits 284 out of existence.

Dynamic Behavior of Consulatee 143 Decision Role

10 **121 Object.** As depicted in FIG. 17 the Consulatee 143 object is instantiated 290 in Dormant 291 state. Upon the start of consultation it transits 292 to Consultation 293 state. When end consultation occurs the Consulatee 143 object transits 294 to Standby 295 state. If any related inspection fails, or approval is denied, or the related Decision 100 object is iterated, the Consulatee 143 object returns 296, 297, or 298 respectively to Dormant 291 state. The three states of the Consulatee 143 object aggregate to InProcess 301 state. If the Project 127 object of which the Consulatee 143 object is a component, aborts, the Consulatee 143 object transits 302 out of existence. Upon completion of the project, the Consulatee 143 object transits 300 out of existence.

Dynamic Behavior of Inspector 145 Decision Role

25 **121 Object.** As depicted in FIG. 18 the Inspector 145 object is instantiated 310 in Dormant 311 state. Upon decision entry it transits 312 to Inspection 313 state. If all inspections pass the Inspector 145 object transits 315 to Standby 316 state. If any inspection fails, or the related Decision 100 object is iterated, the Inspector 145 object returns 314 or 317 respectively to Dormant 311 state. If the related Decision 100 iterates while the Inspector 145 object is in Standby 316 state, the

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Inspector 145 object transits 318 to Dormant 311 state. The three states of the Inspector 145 object aggregate to InProcess 320 state. If the Project 127 object of which the Inspector 145 object is a component, aborts, the
5 Inspector 145 object transits 321 out of existence. Upon completion of the project, the Inspector 145 object transits 319 out of existence.

Dynamic Behavior of Approver 144 Decision Role 121 Object. As depicted in FIG. 19 the Approver 144 object is
10 instantiated 330 in Dormant 331 state. Upon decision entry it transits 332 to Approval 334 state, provided that there are no Inspector 145 objects related to this Decision 100 object. If there are Inspector 145 objects related to this Decision 100, the Approver 144 object
15 transits 333 to Approval 334 state upon all inspections being passed. If all approvals are granted the Approver 144 object transits 336 to Standby 337 state. If any approval is denied, or the related Decision 100 object is iterated, the Approver 144 object returns 335 or 338
20 respectively to Dormant 331 state. If the related Decision 100 iterates while the Approver 144 object is in Standby 337 state, the Approver 144 object transits 339 to Dormant 311 state. The three states of the Approver 144 object aggregate to InProcess 341 state. If the
25 Project 127 object of which the Approver 144 object is a component, aborts, the Approver 144 object transits 342 out of existence. Upon completion of the project, the Approver 144 object transits 340 out of existence.

Dynamic Behavior of Informee 146 Decision Role 121 Object. Although Informees are required to act on the
30 information they receive, they are often playing some other Decision Role 121 in a subsequent Decisions 100 which require 103 the Data 104 of the producing 110

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Decision 100 and are therefore Informees 146 of producing
103 Decision 100 they do not need to be modeled as
Informees 146 because the inter-decision model structure
handles their notification. If, however, an Informee's
5 146 need is associated with a Decision 100 that is beyond
the model scope (i.e., is either unknown to the subject
model or is undefined), messages (e.g., E-mail, office
mail) must be sent to the Informee's 146 address of
record. That is the function of the Informee 146 object.
10 FIG. 20 depicts the dynamic behavior of the Informee 146
object. Upon instantiation 350 the object enters Dormant
351 state. Upon data release the Informee object 146
transits 352 to Standby 353 state and sends a message to
the role incumbent containing the Data 101 and the state
15 (i.e., released but not yet operational). If the Project
127 iterates across the Decision 100 while an Informee
146 object of that Decision 100 is in Standby 353 state,
the Informee 146 object transits 354 to Dormant 351 state
and sends a message to the Informee 146 role incumbent
20 indicating the change to Dormant 351 state. If the
Project 127 aborts while an Informee 146 object of a
Decision 100 is in Standby 353 state or Dormant 351
state, the Informee 146 object transits 356 or 357
respectively out of existence and sends a message to the
25 Informee 146 role incumbent indicating the change. If the
Project 127 completes while an Informee 146 object of a
Decision 100 is in Standby 353 state, the Informee 146
object transits 355 out of existence and sends a message
to the Informee 146 role incumbent indicating the change.

30 **Table B** indicates the concurrent states of the
principal objects of the model (State = "None" before
instantiation and after destruction of an object. State =
"Dormant" after instantiation but before first use of an
object. State = "Standby" pending possible need to

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iterate project prior to completion.). The vertical dimension is time, but is not to scale. Therefore the length of overlap is not significant. For example, the Directed Arc with an exit related to the decision will be active before the Decision can transit from "Dormant" to "Decision Release Pending" as indicated by the overlap of the Directed Arc's Active area and the Decision's Dormant area. However, the time of that overlap may be extremely short for some decisions and relatively long for others. States may be skipped or iterated (see the State Diagrams). Any horizontal line will cross possible concurrent states. Where a horizontal line can be drawn from a state on one object to multiple states of another object (e.g., Active state of Directed Arc (entry) to Dormant and Decision Release Pending states of Decision) all of the combinations are possible.

Functional Model

Project Instantiation. When a Project 127 is instantiated 128, other objects are also instantiated as follows. Referring to FIG. 21, the Project Manager 700 identifies the concrete sub-class of the abstract Decision 100 class from which the initial decision 701 is to be instantiated. The initial decision 701 class is used to select 702 the required decision classes 703 and directed arc classes 704 from the Process 705 object. The selected classes are used to instantiate a Project 706 object and then to instantiate, as components of the Project 706 object, an instance of the identified Decision 100 sub-class together with an instance of every Decision 707 and Directed Arc 708 that is directly or indirectly dependent on the initial decision 701. Instances of all the required Arc Exit Collection 709

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objects and Arc Entry Collection 710 objects are also created within the Project 706 object.

Decision Role Instantiation. As depicted in FIG. 22, a Decision 720 object uses its decision 721 identification to select 722 the required decision role classes 723 and positions 724 from the Process 725 object. These are used to create an instance of each required Decision Role 726 participant as components of the Project 727 object.

Data Instantiation. FIG. 23 depicts the instantiation of Data objects. A Decision 730 object provides its decision 731 identification which are used to select 734 the appropriate data class 735 from the Process 736 object. The Decision 730 object also furnishes the value of its data hold/release 732 attribute which is used to instantiate the Data 737 object with the hold/release value and state, as a component of the Project 738 object.

Project Iteration. During the course of a project, it may become necessary to revisit a decision that has already been made, inspected, approved and its released for use in other project decisions. Any decision instance that is in a non-dormant state is a potential candidate for iteration. When a decision is iterated the result may change and therefore, all decisions that use that result must also be iterated. Hence, decision iteration usually entails iteration of that portion of the project that is both active and "downstream" from the decision to be iterated. FIG. 24 depicts the functional model of project iteration. The Project Manager 750 identifies the decision to be iterated 751. The first step 752 is to send a "pause" 753

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message to the Project 754 object. Then The decisions 755 and directed arcs 756 are retrieved from the Project 754 object and those that are dependent on the decision to be iterated are selected. The state 759 of each of the
5 previously selected decisions is retrieved from the Decision 758 objects and those which are in non-dormant state selected 760. The identification of the selected decisions 763 together with the "iterate" 764 message is sent to the Decision 758, Data 765 and Decision Role 766
10 objects. Finally, the project is resumed 767 by sending a "resume" 768 message to the Project 754 object.

While the present invention has been described with reference to a few specific embodiments, the description is illustrative of the invention and is not to
15 be construed as limiting the invention. Various modifications may occur to those skilled in the art without departing from the spirit and scope of the invention as defined in the appended claims. For example, it would be natural to make the "data hold/release"
20 toggle an attribute of the Data 101 object. However, the preferred embodiment defers the instantiation of Data 101 objects until they are required for entry of the Decision 100 result. It is desirable to be able to specify a hold on the release of the decision result at the time the
25 Project 127 object is created. There are a variety of ways that this might be accomplished. The Data 101 object could be instantiated at Project 127 inception or all "data hold/release" attributes might be placed in an object instantiated for this purpose at Project 127
30 inception and pass them to Data 101 objects when the latter are instantiated. The preferred embodiment is to carry the "data hold" attribute value in the Decision 100 object, which is instantiated at Project 127 inception

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and pass it to the Data 101 object as the latter is instantiated.

A further example is the time chosen to instantiate the Inspector 145 and Approver 144 objects.

5 Our preferred implementation instantiates them at the same time as the other Decision Role 121 objects on the expectation that there will be relatively few of them and that the model of their classes and relationships in the Process 129 model will be relatively stable. They could
10 be implemented with a later instantiation, which would be preferred under circumstances other than those anticipated.

Nor are all the features of the implementation described here essential to the novelty or usefulness of
15 the invention. For example, the ability to place holds selectively on the release of either decisions or their results is a feature that will probably be valued but need not be a part of the implementation. Similarly, the distinction made between the Inspector 145 and Approver
20 144 roles adds utility, but is not essential to the invention. These details of implementation are presented for their illustrative value and may be altered to accommodate the particular trade-offs of a specific application situation. They do not have any bearing on
25 the scope or novelty of the present invention.

What is claimed is:

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TABLE A. DECISION ROLES AND RESPONSIBILITIES

ROLE NAME	ROLE	RESPONSIBLE TO ..	RESPONSIBLE FOR ..
Decision Manager	Manage the decision process, make the decision and take responsibility for its implementation	The Organization	Providing a timely, efficient and effective decision-making and implementation process.
		Consultees	Providing an opportunity to influence the decision before it is made.
		Approvers	Submitting the decision for approval after it has been made, but before any commitment is made to implementation.
		Informees	Providing timely notification of the decision made, after it has been made.
Consultee	Provide expertise required to make a good decision or the commitment of resources needed for its successful implementation. (Cannot veto.)	The Organization	Contributing expertise and resources which will improve the decision of its implementation.
		Decision Manager	Adhering to the decision process, providing Decision Manager with relevant expertise, taking responsibility for influencing and accepting the result when the opportunity to influence has been provided.
Approver	Prevent organizationally intolerable outcomes that might result from a decision made without the benefit of expertise which is not otherwise available to the Decision Manager, and assure that the decision has not been unduly influenced by the parochial interests of the Decision Manager to the detriment of the organization. (Can veto.)	The Organization	Assuring that the Decision Manager has not made a decision that favors parochial interests at the expense of the organization's welfare or that will expose the organization to unacceptable risk.
		Decision Manager	Making the requirements for decision approval as clear and as specific as possible, before the decision process begins, and providing timely notification of approval or disapproval with the reasons for such disapproval.
Inspector	Ensure that the result of the decision conforms to the established specifications for the decision result. (Can reject.)	The Organization	Assuring that the decision result conforms to all established specifications.
		Decision Manager	Assuring that the Decision Manager is aware of the result specifications before the decision is made and informing the Decision Manager of the inspection results (including the reasons for any failure to pass inspection) as soon as possible after the decision has been made.
Informee	Make subsequent decisions and perform subsequent tasks in a manner that is consistent with it.	The Organization	Making all subsequent decisions and performing all subsequent tasks in a manner that is consistent with the decision made.

Object	Project	Directed Arc (Exit)	Decision	Decision Manager	Consultee	Data	Inspector	Approver	Informee	Directed Arc (Entry)
State	Active, Paused or Suspended	Dormant	Dormant							
			Decision Release Pending							
			Prepare Consultation	Prepare Consultation	Dormant					
			Consultation	Consultation	Consultation					Dormant
		Active	Deliberation	Deliberation		Entry Pending				
			Inspection			Inspection or Approval	Inspection			
			Approval				Approval			
			Standby	Standby			Standby	Standby		
						Standby			Standby	
										Active

Table B. Object Concurrency

1. A method for instantiating project models as instances of a process model to which they conform comprising the steps of

supporting the work in process by rendering said
5 process models as elements of a computer-based system,
and

supporting the work of the process by rendering said project models as elements of a computer-based system.

10 2. A method for modeling work processes comprising the steps of

instantiating a plurality of objects by abstract or concrete classes, and including at least a decision class and a data class,

15 relating each decision object to one or more data objects which it produces,

requiring, for at least one decision object, at least one data object as a prerequisite to its activation or completion, and

20 optionally generating additional subclasses or instances of said decision and data classes.

3. The method of claim 2 further comprising the step of relating an arc or link class linking a first decision with a second decision.

25 4. The method of claim 2 further comprising the steps of

generating a decision role class specialized into at least two subclasses, each with differing behaviors,
and

30 defining for each decision role class the communication requirements among the incumbents of roles participating in a decision, the rights of each such role

class incumbents with respect to (a) entering data elements in a database, (b) modifying elements in a database and/or (c) reading elements from a database.

5. A method for traversing networks including
5 nodes and directed arcs comprising the steps of
utilizing messaging between said nodes and arcs
and collections of said arcs, and
determining the membership of said collections by
at least one of their entry nodes and exit nodes.

10 6. A method of modelling and managing work
processes comprising the steps of
using a network whose nodes are abstract decision
situations, and
providing arcs directed by decisions based on
15 logical precedence.

7. The method of claim 6 further comprising the
step of
requiring nodes to support participation of
multiple persons in differentiated roles.

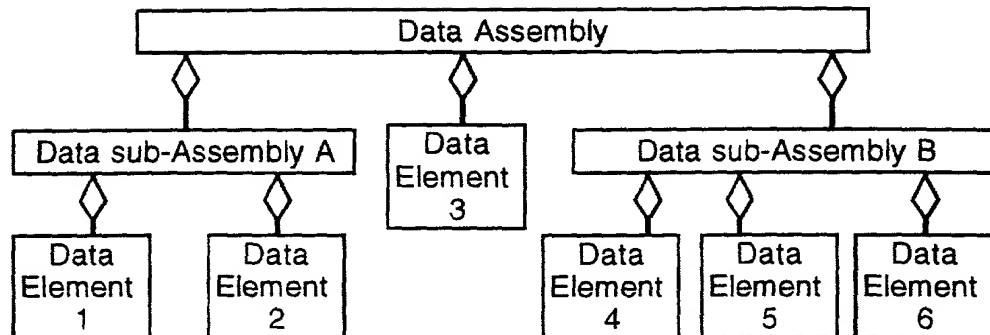


Fig. 1

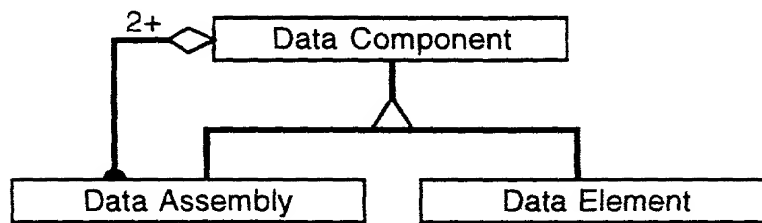


Fig. 2

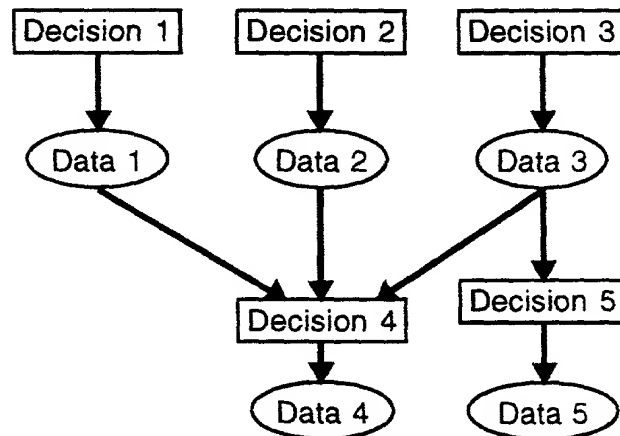


Fig. 3

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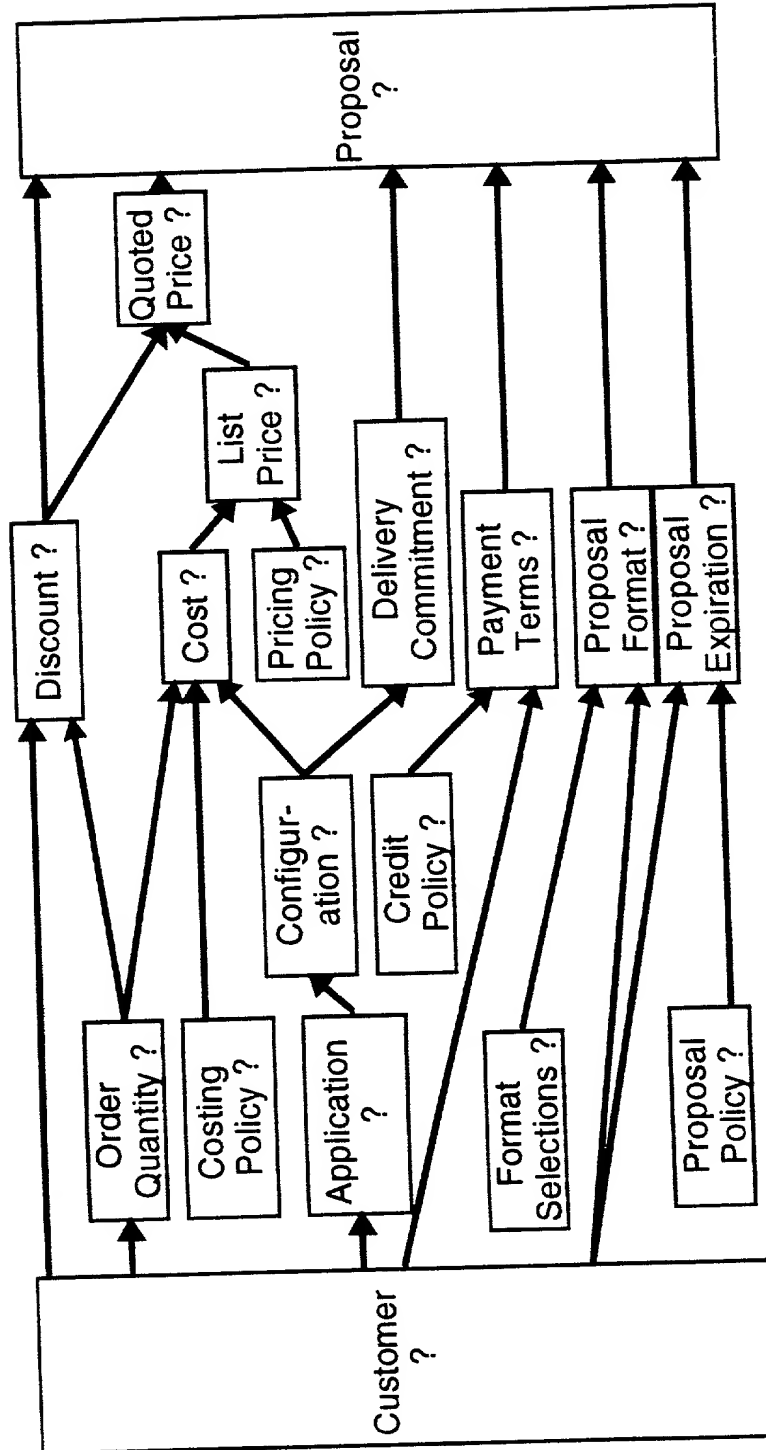


Fig. 4

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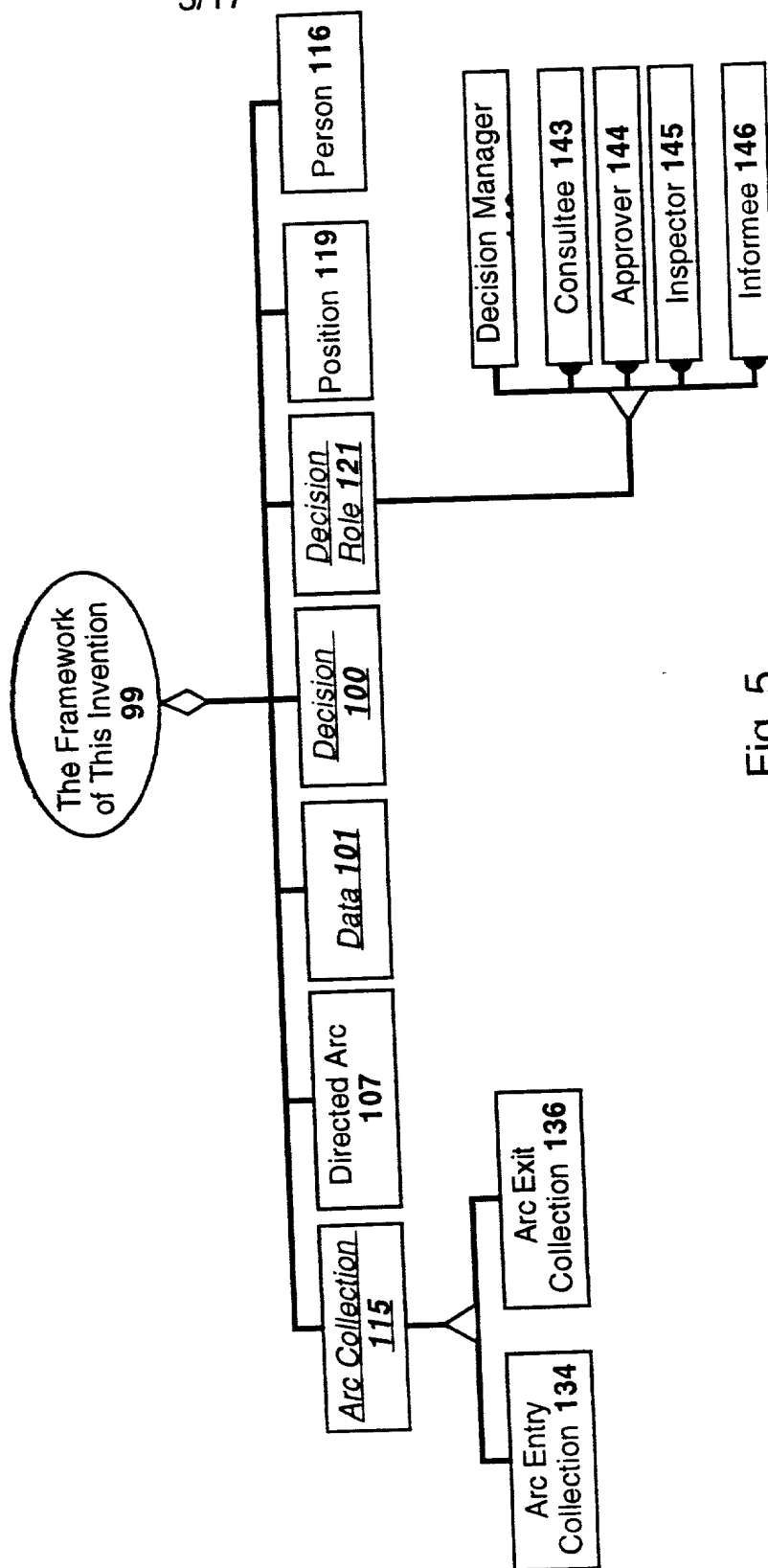


Fig. 5

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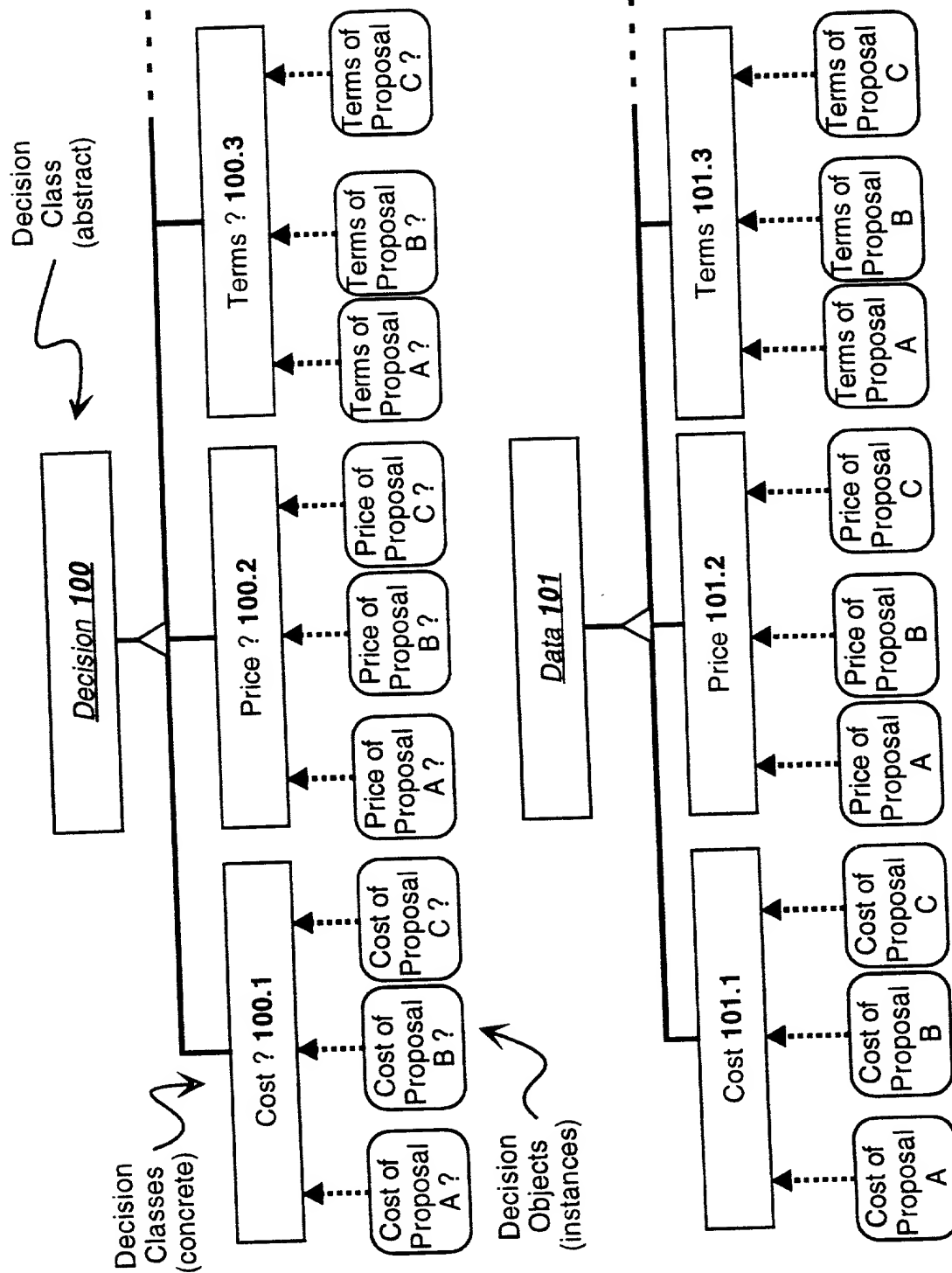


Fig. 6

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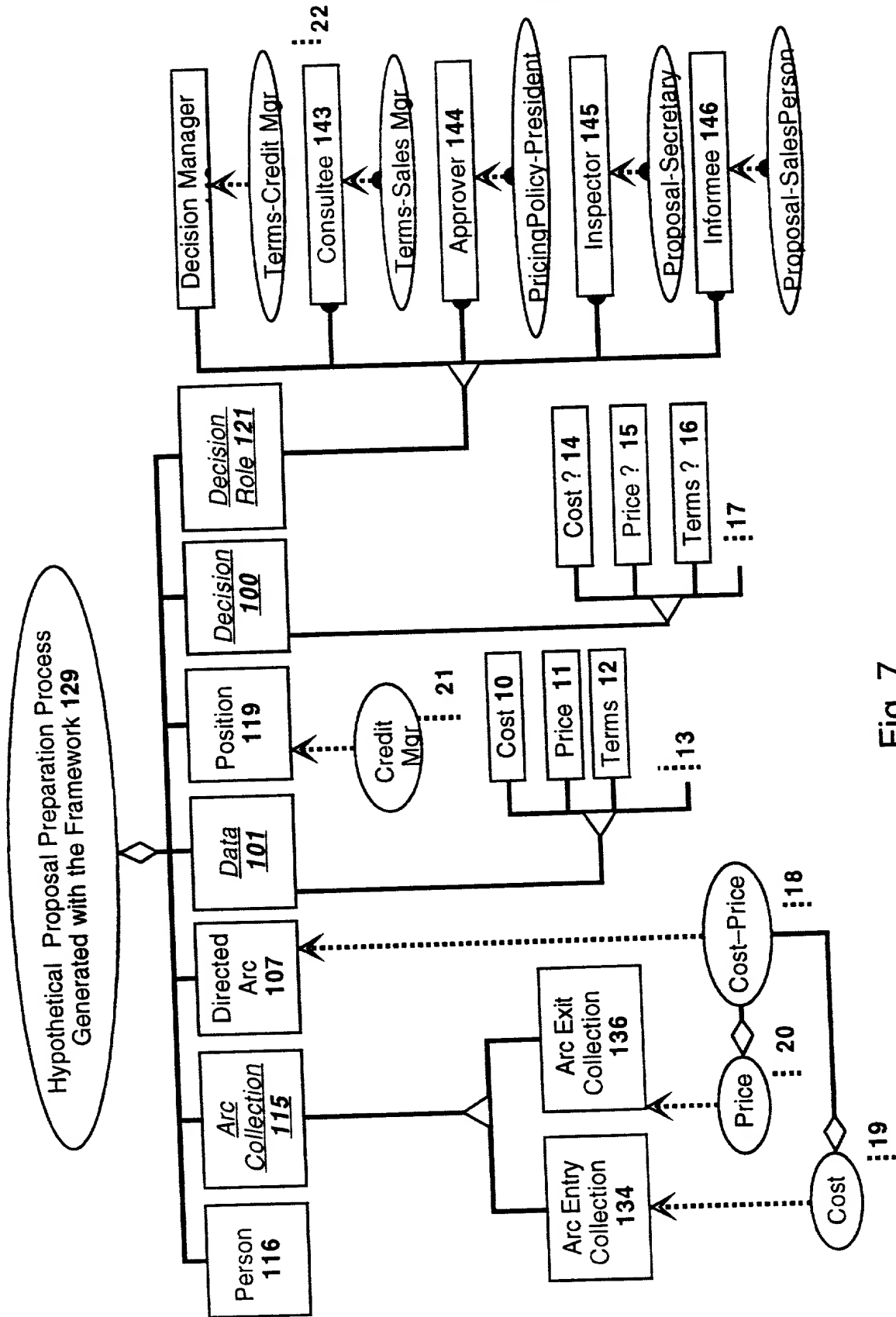


Fig. 7

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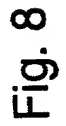


Fig. 8

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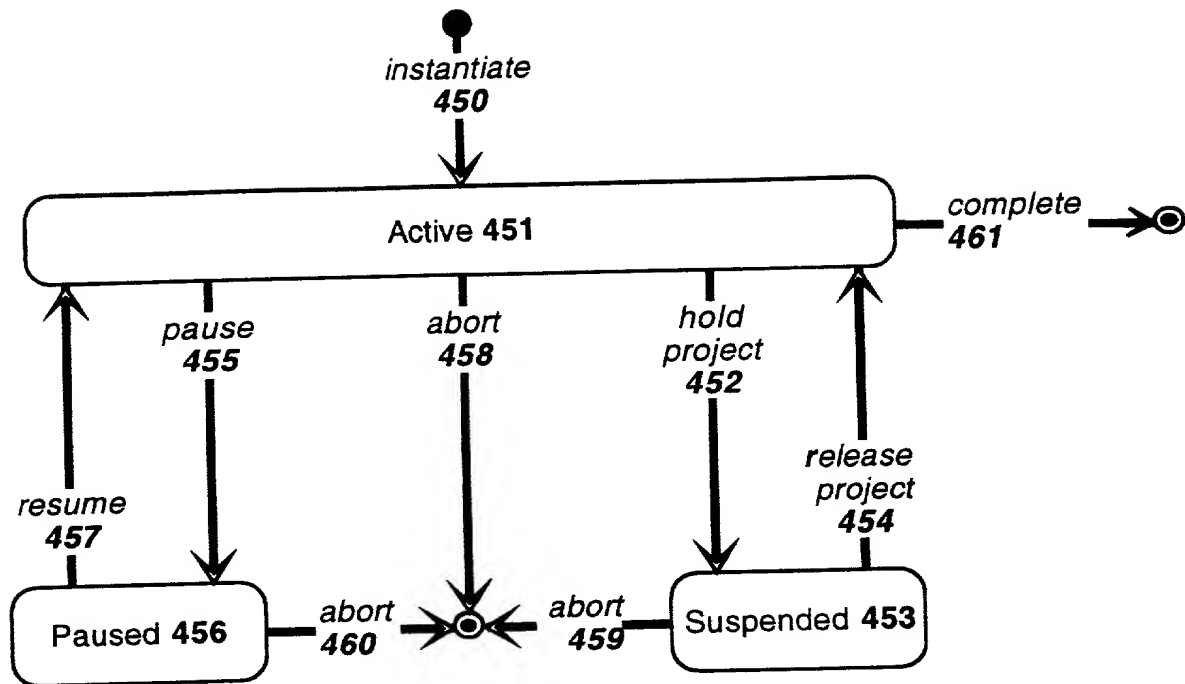
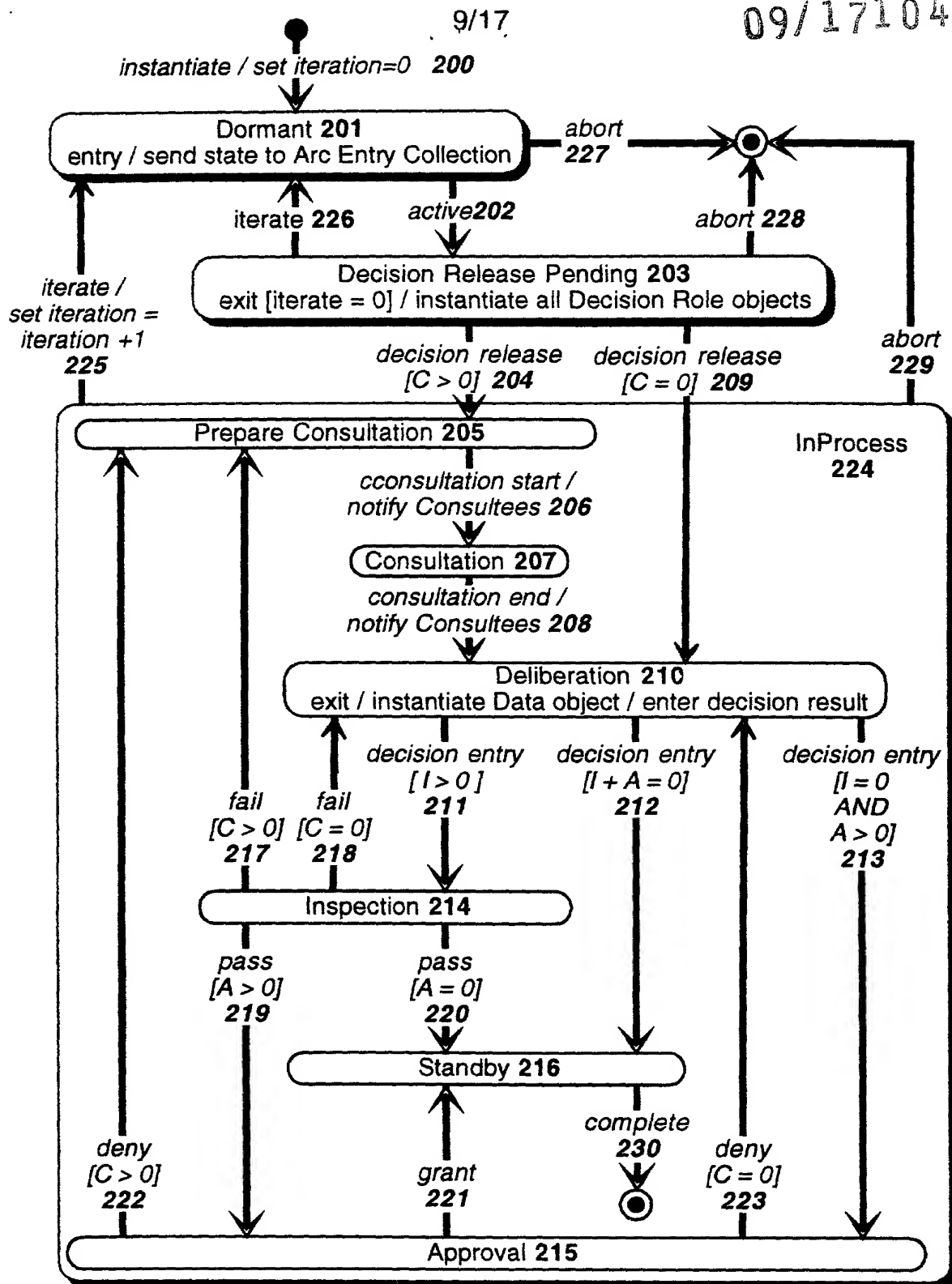


Fig. 10

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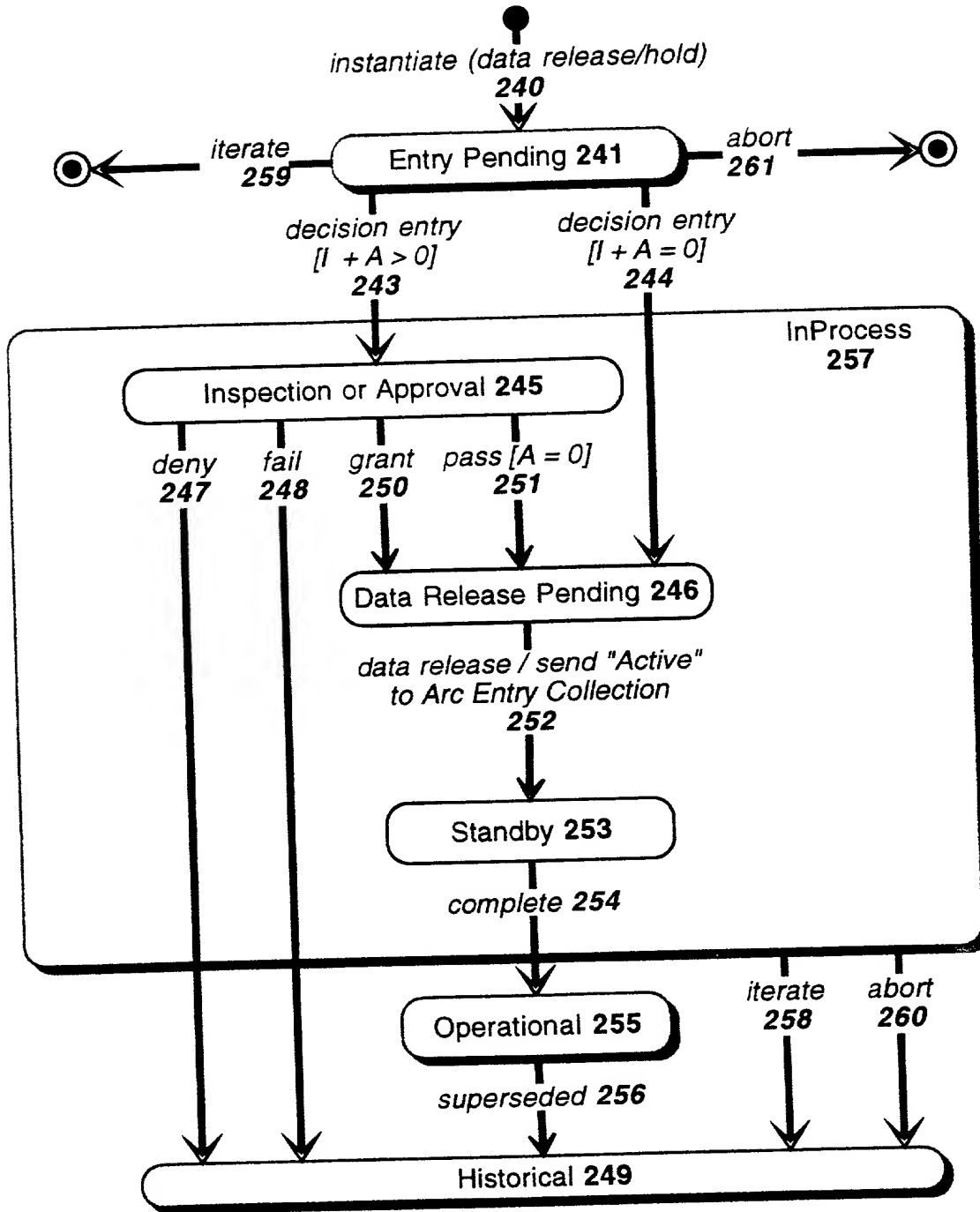


Notes: "C" is the number of Consultees designated for the Decision,
"I" is the number of Inspectors designated for the Decision, and
"A" is the number of Approvers designated for the Decision.

Fig. 11

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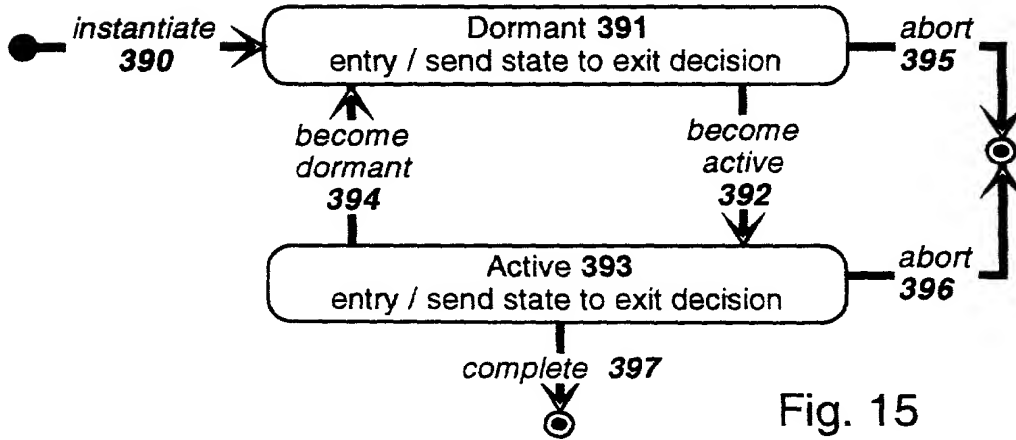
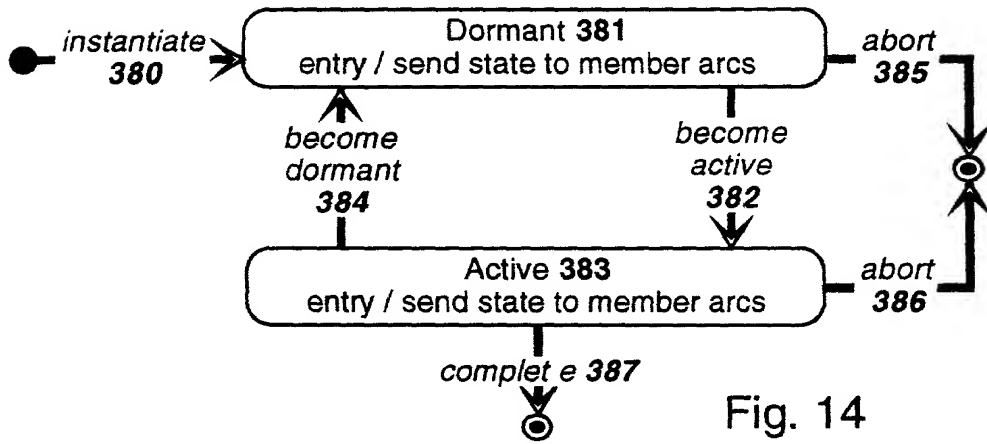
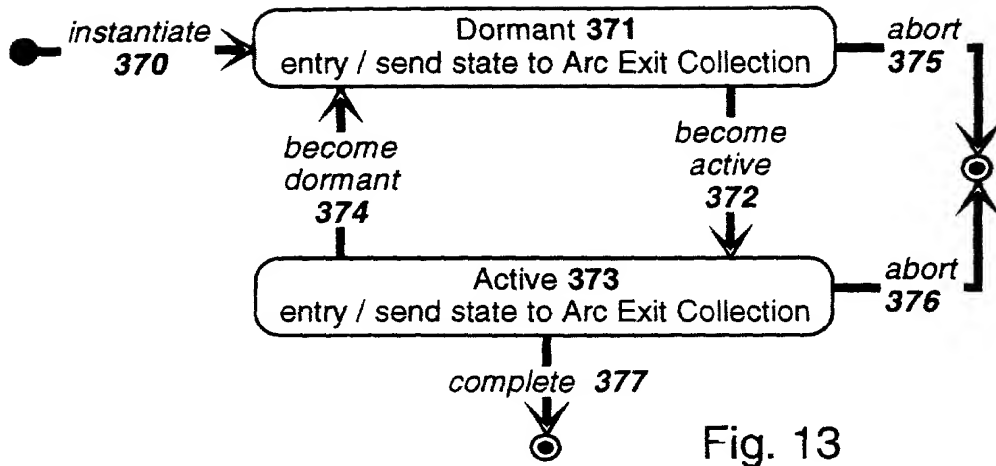


Notes: "I" is the number of Inspectors designated for the producing Decision, and "A" is the number of Approvers designated for the producing Decision.

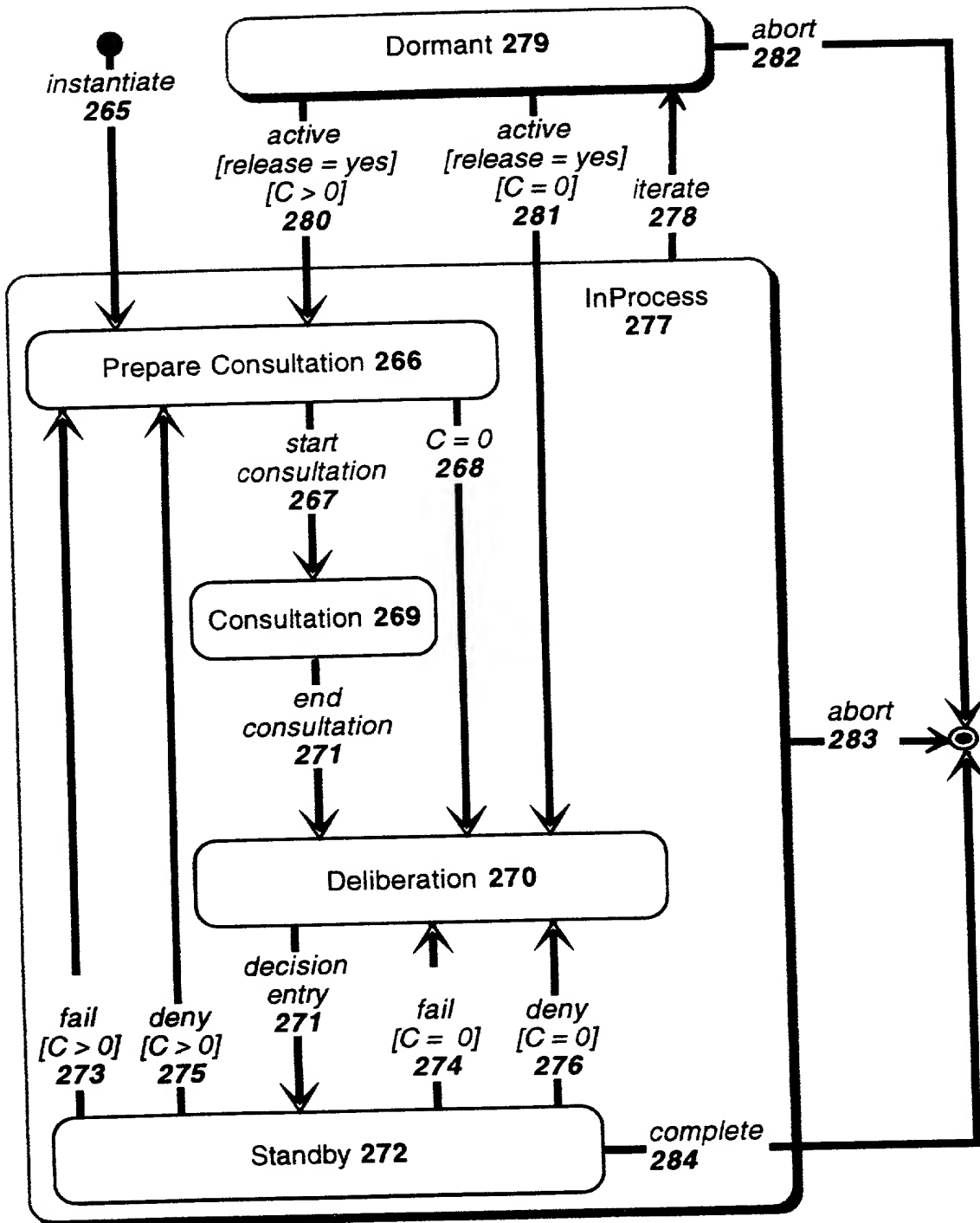
Fig. 12

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Note: "C" is the number of Consultees designated for the producing Decision.

Fig. 16

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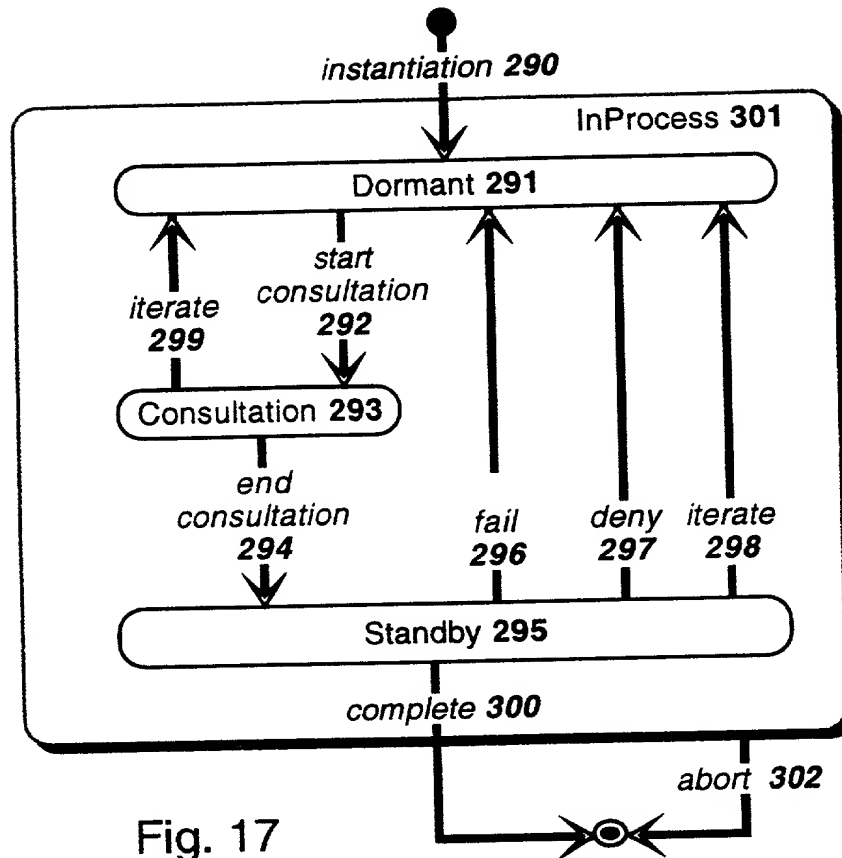


Fig. 17

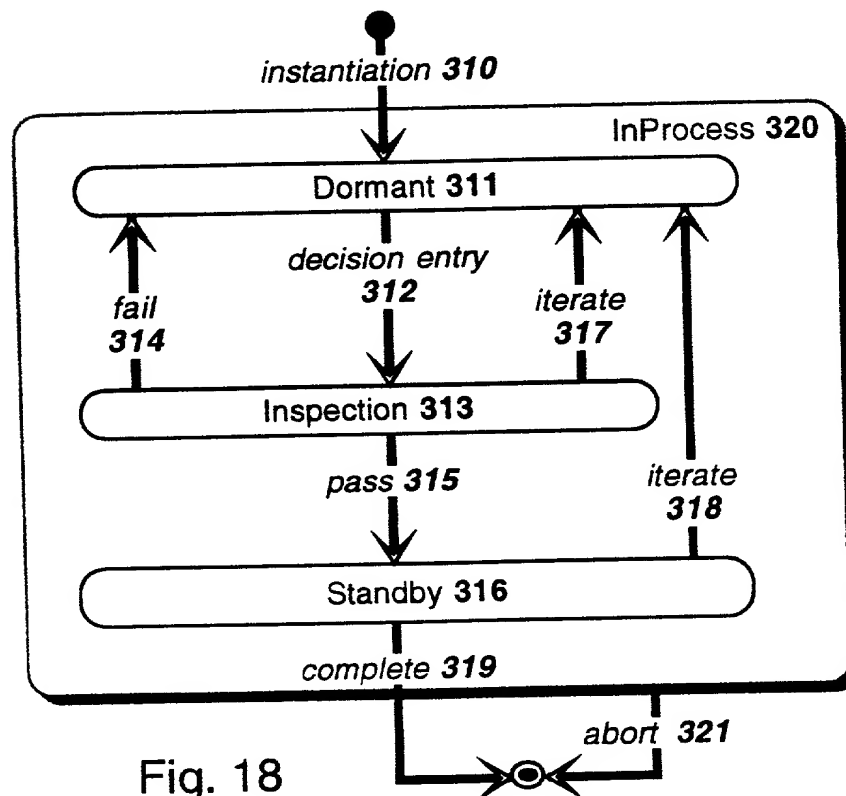


Fig. 18

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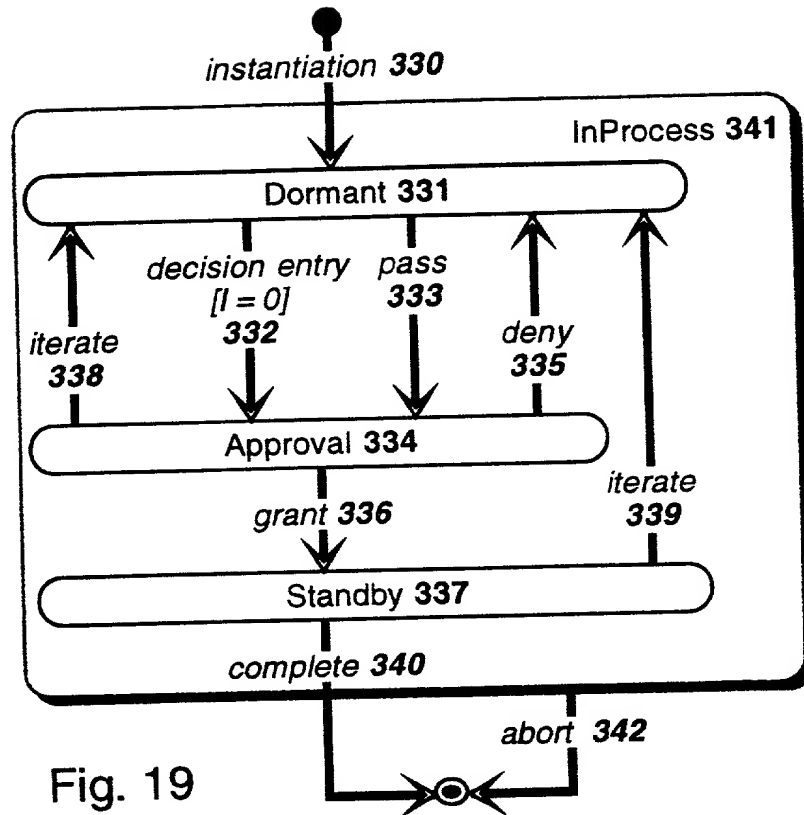


Fig. 19

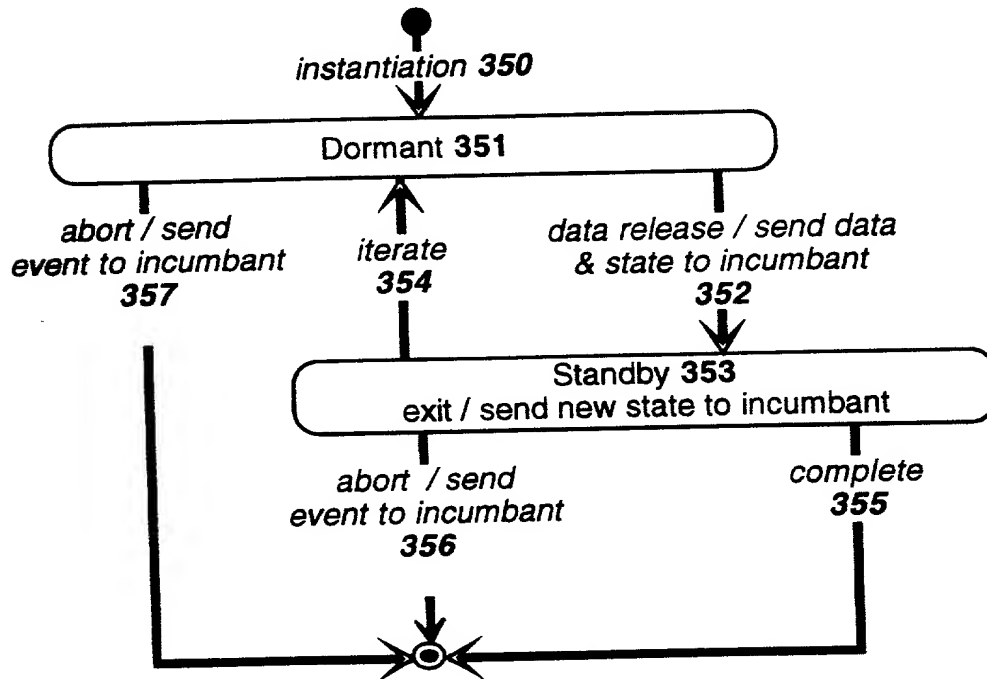


Fig. 20

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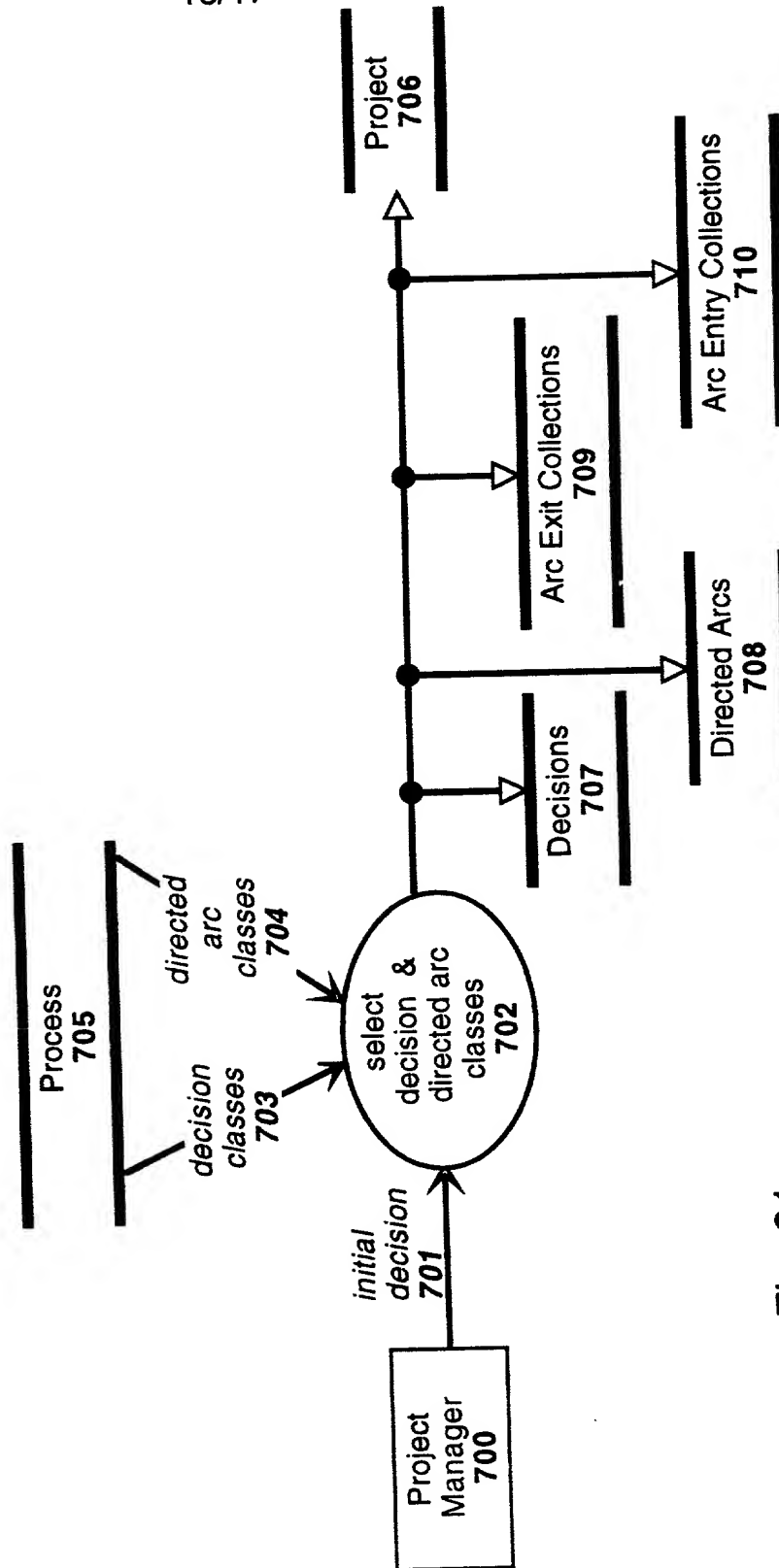


Fig. 21

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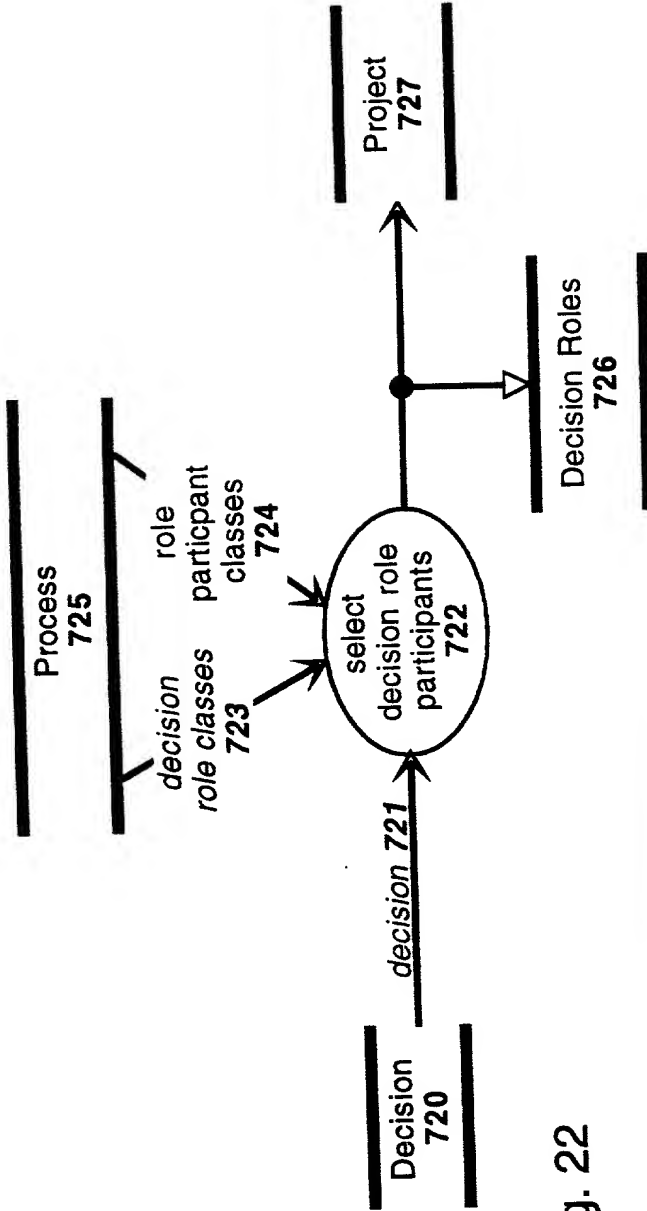


Fig. 22

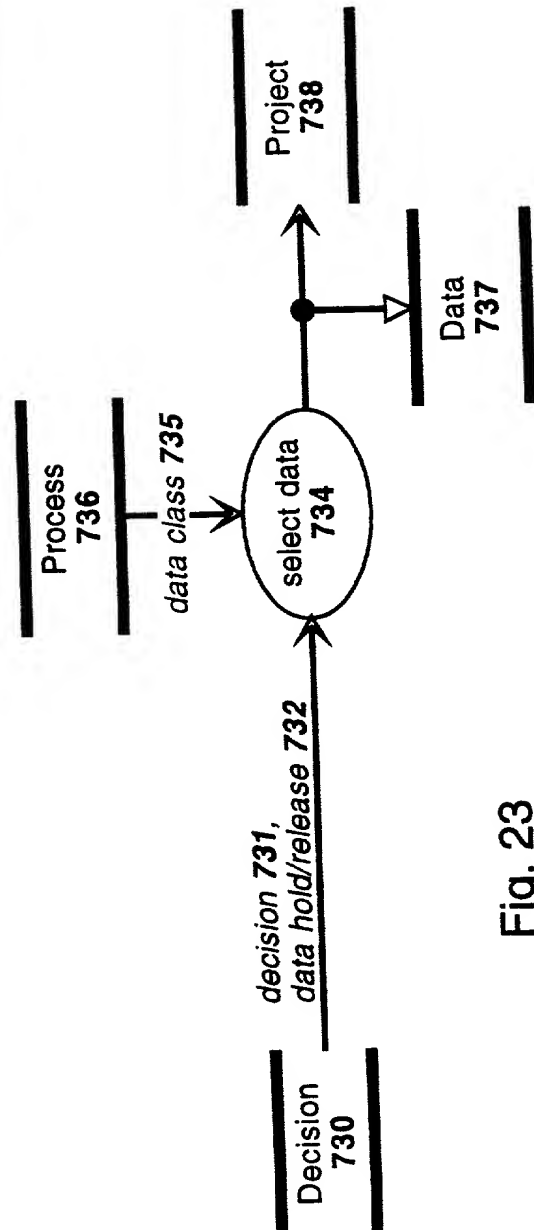


Fig. 23

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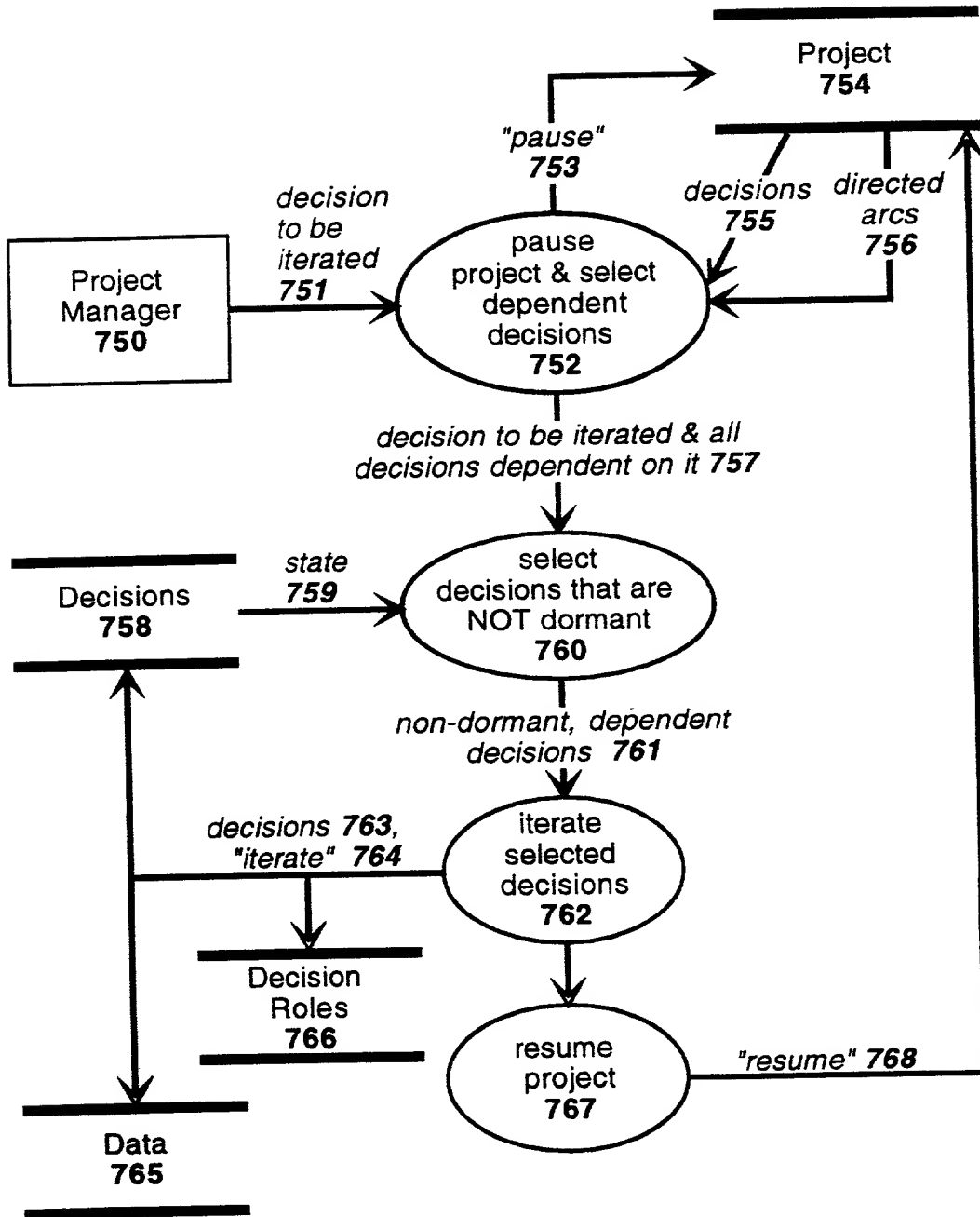


Fig. 24

ATTORNEY DOCKET NO. 08086/002002

Applicant or Patentee: Paul M. Konnersman

Serial or Patent No.:

Filed or Issued:

For:

Herewith

COMPUTER-BASED SYSTEM FOR WORK PROCESSES THAT CONSIST OF INTERDEPENDENT DECISIONS INVOLVING ONE OR MORE PARTICIPANTS

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) and 1.27(b)) - INDEPENDENT INVENTOR**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled METHOD FOR THE ANALYSIS, SPECIFICATION AND COMPUTER-BASED SUPPORT OF WORK PROCESSES THAT CONSIST OF INTERDEPENDENT DECISIONS AND THAT REQUIRE MULTIPLE PARTICIPANTS IN AT LEAST SOME OF THOSE DECISIONS described in

- ☒ the specification filed herewith.
☐ application serial no. , filed .
☐ patent no. , issued .

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ no such person, concern, or organization.
☐ persons, concerns or organizations listed below*.

*NOTE: Separate verified statements are required from each named person, concern, or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

Full Name: _____

Address: _____

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status when any new rule 53 application is filed or prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Inventor: Paul M. KonnersmanSignature: Paul M. KonnersmanDate: October 9, 1998

PATENT
ATTORNEY DOCKET NO: 08086/002002

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled COMPUTER-BASED SYSTEM FOR WORK PROCESSES THAT CONSIST OF INTERDEPENDENT DECISIONS INVOLVING ONE OR MORE PARTICIPANTS, the specification of which

☒ is attached hereto.

☐ was filed on _____ as Application Serial No. _____
and was amended on _____.

☒ was described and claimed in PCT International Application No. PCT/US97/05969 filed on 10 APRIL 1997 and was amended on 07 NOVEMBER 1997.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

COUNTRY	APPLICATION NO.	FILING DATE	PRIORITY CLAIMED
_____	_____	_____	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose all information I know to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

U.S. SERIAL NO.	FILING DATE	STATUS
<u>60/016,080</u>	<u>10 APRIL 1996</u>	<input type="checkbox"/> Pending <input type="checkbox"/> Issued <input checked="" type="checkbox"/> Abandoned
<u>PCT/US97/05969</u>	<u>10 April 1997</u>	<u>X</u>

I hereby appoint the following attorneys and/or agents to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Gary A. Walpert, Reg. No. 26,098; Timothy A. French, Reg. No. 30,175; John N. Williams, Reg. No. 18,948; Charles C. Winchester, Reg. No. 21,040

Address all telephone calls to Gary A. Walpert at telephone number 617/542-5070.

Address all correspondence to Gary A. Walpert, Fish & Richardson P.C., 225 Franklin Street, Boston, MA 02110-2804.

COMBINED DECLARATION AND POWER OF ATTORNEY CONTINUED

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

100 Full Name of Inventor: Paul M. KonnersmanInventor's Signature: Paul M. KonnersmanDate: October 9, 1998Residence Address: 272 Ocean Avenue, Marblehead, MA 01945-3730Citizen of: United States of America MAPost Office Address: 272 Ocean Avenue, Marblehead, MA 01945-3730